PLANT COMMUNITIES OF SELECTED DUNES AND SANDY AREAS OF FLORIDA – AS LABORATORIES FOR HIGH SCHOOL BIOLOGY

By

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INTRODUCTION

Use of plant material in its original habitat as a teaching aid in a most effective way for teachers to convey the meaning of plant community relationships to students. In many Florida high school biology classes students learn of the plant community relationships that can be observed in other parts of the United States or of the world. The biological significance of these relationships is certainly valid in Florida, but the remoteness of the examples lessens the effectiveness of their use. Florida students are near many localities that can be used to illustrate the effects of the environment on plants and of plants on the environment. In these situations, the significance of different biological relationships can be seen. When students discover that many of these same biological relationships can be observed within a short distance of the class room, the avenue to effective use of instructional plant material in its original habitat is open.[1]

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[1] Ida Beth Schulte, "A Way of Developing Children's Understanding of Ecology" (unpublished Doctoral dissertation, University of Florida, 1955), P. 5. Schulte comments on the lack of available teaching material specifically related to Florida.

When a teacher is aware of the plant material in his area and has made careful plans, work in the field may become an effective learning experience. In such work, each student should be a part of a team that is about to undertake a scientific investigation. There are measurements and observations to be recorded. Every student should be ready to detect the unforeseen and the unusual. Field work should be carried out in accordance with the requirements of a scientific study. The purpose of this study is to suggest an approach to the use of plant communities in an area by (1) presenting research in nine selected locations and (2) suggesting ways of applying the findings of this research in biology classes.

Statement of the Problem

Plant communities in dunes and sandy areas in the state were selected where the effects of environmental influences upon vegetation could be observed. The most noticeable of the influences are pointed out. Then the information is organized for effective use in teaching high school biology.

Two criteria were used in choosing the plant communities. First, the boundaries of a community must be clearly defined. For example, the purpose of this study is not served in a situation where the plants of two distinct communities intermingle. Second, the areas must contain evidence of environmental influences that can be used as teaching material.

Certain of these influences are made conspicuous by their effects upon plants and soil. For example, wind influences the direction of growth of many plants as well as the topography of the land.

In addition to the basic criteria used in the selection of plant communities, certain other less obvious factors are considered. Among these are the effect of wind upon shoreline vegetation and the effect of wind upon sand movements and formations along the beach. For example, the most noticeable effect of the wind upon certain sea shore vegetation is the wind-blown shape of the vegetation. Many people assume that the constant wind pressure bends the tender twigs all in one direction away from the shore. Is their observation in accordance with the facts?

Another example of a result of wind action is the constant movement of sand away from the beach. The wind blows the sand for days and weeks at a time. What makes it begin to pile up into dunes? What makes the dunes remain in one position and increase in size? Close examination may reveal that sand begins to accumulate around a sprig of grass. As time passes, the grass grows and the dune becomes larger. In this case the sand is brought by wind, but it is held in place by the vegetation. The vegetation is as important as the wind in dune formation.

In this study, the obvious forces and their effects have been identified. The less obvious forces, as pointed

out above, are also a vital part of the environment and are discussed. Many of these subtle forces are identified for a particular location at a given time. Suggestions for studying these factors in a biology class are included.

Material is organized from two points of view. First, plant communities were selected and located geographically to show the teacher where well defined communities are present in areas that are likely to remain undisturbed. Second, plant communities have been discussed in the light of the various environmental factors that can be observed in them. H. J. Arnold has used similar methods in organizing teaching material for the study of earth science.[2]

A part of this study provides descriptions of class activities that can be employed to investigate some of the problems that will arise from class discussions and field observations. A number of field experiments suitable for individual or class projects are suggested. The detection of environmental changes, for the most part, necessitates a period of observation in terms of months or years.

Limitations and Definition of Terms

Areas included in the study are only those from the coastal sand dune regions and the sandy lake regions of

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[2]Herbert J. Arnold, Localities for Field Work in Earth Science (New York: Teachers College, Columbia University, 1936).

Florida. These dune areas extend from Fernandina Beach down the east coast to Fort Lauderdale and from Fort Myers on the west coast to the mouth of Mobile Bay. The sandy lake areas extend from northeast Florida down the ridge section to the lower end of Highlands County. Thus a limit was placed upon the number of kinds of plant communities to be studied by the selection of certain geographical locations.

Active sand dunes are a part of the study. An active dune may be defined as a dune in a state of change. Toward the shore line an active dune may be increasing in size from sand blown upon it by the wind. Further away from the shore an active dune may be accumulating more sand or losing sand. This later stage is evolving into a more stable condition.

Stabilized dunes are also included in the study. In a stabilized dune the sand has become relatively static as a result of plant growth and possibly other factors. This type of dune is usually found a short distance inland from the active dunes.

The sandy areas in the lake regions, included in the study, are defined according to their soil classification, which are the white sand deposits of St. Lucy and Lakewood soil types, and yellow and grey sands of the Lakeland and Blanton soil types.

Certain plant communities are restricted to soil types. A sand pine community is usually found growing on St. Lucy or Blanton soil. Thus, by indicating the soil type of an

area in Florida, one is implying the kind of vegetation that may occur on this soil.[3] Selected plant communities found on each of these soil types are studied.

The term "community" as applied to a group of associated plants is employed throughout this work. It designates a complex organization of living plants in recognizable units of vegetation.[4,5]

Population centers were considered in the selection of areas for demonstrative purposes. Recognition was given to the need for readily accessible locations near the school; however, as the population expands, more and more areas will be utilized for habitation and industrial purposes. This human interference will render many plant communities useless for controlled studies on natural environmental influences. Consequently, some areas now remote from population centers are included.

In describing the plant communities, a few conspicuous plants are used to identify the communities. Sand pine, Pinus clausa, serves to designate a Sand-Pine Scrub Community. The name of a dominant plant or a combination of

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[3]The relationship between soil types and the distribution of vegetation may be seen by comparing soil and vegetational maps of the state.

[4]John E. Weaver and F. E. Clements, Plant Ecology, (2nd ed.; New York: McGraw-Hill Book Co., Inc. 1938), p. 104.

[5]Henry J. Oosting, The Study of Plant Communities, (San Francisco, California, W. H. Freeman and Co., 1953), p. 21. This author along with Weaver and Clements uses the term community in a similar fashion which implies no special rank or level of organization.

dominant plants is taken as the name of a plant community. There may be other plants consistently present in a sand pine community and some of the more conspicuous of these are included in the study. Plants mentioned are limited to easily identifiable ones that occur in each plant community discussed. There is some variation in plant species present in similar but widely separated areas.

Terminology is simplified. Emphasis is placed upon the observation, measurement, and interpretation of environmental effects upon vegetation.

Selection of Areas

Areas selected for illustrative purposes are primarily those that are located near population centers.[6] Priority was given to accessible areas that can be used best to demonstrate the presence of environmental influences. Some of these factors are wind, fire, rainfall, drainage, salt spray, temperature, soil type, and light intensity.

Plan of Discussion

Chapter two presents a discussion of the origins of Florida sands, with particular reference to geological history and soil types. In chapter three the findings from the study of the selected plant communities are given.

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[6] See Figure 15, p. 102 for the location of areas selected for this work.

Suggestions for the use of plant communities as laboratories are presented and discussed in chapter four. The concluding chapter is concerned with the major findings and proposals for future research.

CHAPTER II

ORIGIN OF FLORIDA SANDS

A review of pertinent geological history is a necessary background to the study of Florida plant communities. This review will present a few fundamental assumptions about the land formations of the state. The nature of the exposed soils will be discussed with respect to the influences that caused their formation. Parent material, method of formation, and climatic influences are factors in the development of a soil. Since soils provide the foundation for vegetation, their origin is of importance in the occurrence of plant communities. At the present time Florida is influenced greatly by the surrounding sea. During the past ages the sea may have been one of the most important factors in shaping the present Florida landscape.

Geological History

Geological history is expressed usually in terms of millions of years. Geologists have made tentative calendars dividing time into several units. The largest divisions of time are called eras. The eras are divided into periods and

the periods into epochs.[1] Geologists believe that the earth is more than 4,000,000,000 years old (see Table 1). During these billions of years many changes have occurred in the earth's crust. Continents have risen and seas have flooded. Mountain ranges have been created by pressure changes under the crust and have been worn down by the effects of climate. These drastic changes have been detected and dated by geologists from their studies of rock formations. The Archeozoic era represents the earliest time of the earth's history. The Cenozoic era represents the most recent period of earth history. As rock formations are dated they are given names. These names may be derived from geographical locations or from some time relationship. Identically dated formations are named for the appropriate period or epoch, even though similar formations may occur in various locations around the earth. The Eocene epoch was named from a marine formation found on both the east and west coasts of the United States. Epochs before and after the Eocene are represented by formations that were deposited earlier and later than the Eocene rock. Names of these other epochs were derived from Greek words that connote degrees of time from earlier to later.

The Eocene epoch as it relates to the geological history of Florida will be used as the starting point in this discussion. During this epoch the area now occupied by the

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[1] R. F. Flint, Glacial and Pleistocene Geology (New York: John Wiley & Sons, Inc., 1957), chapter 16. Flint discusses usage and meaning of these geological time units.

TABLE 1

GEOLOGIC TIME TABLE OF THE UNITED STATES[a]

ERA	PERIOD	EPOCH	MINIMUM (PERIODS) Duration in Years	MINIMUM TIME Since Beginning
CENOZOIC	Quarternary	Recent (post glacial) Pleistocene	1,000,000	1,000,000
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	54,000,000	55,000,000
MESOZOIC	Cretaceous		65,000,000	120,000,000
	Jurassic		35,000,000	155,000,000
	Triassic		35,000,000	190,000,000
PALEOZOIC	Permian		25,000,000	215,000,000
	Pennsylvanian		35,000,000	250,000,000
	Mississippian		50,000,000	300,000,000
	Devonian		50,000,000	350,000,000
	Silurian		40,000,000	390,000,000
	Ordovician		90,000,000	480,000,000
	Cambrain		70,000,000	550,000,000
PROTEROZOIC			500,000,000	1,050,000,000
ARCHEZOIC			800,000,000	1,850,000,000

[a]Compiled in part from information presented by R. A. Daly: The Changing World of the Ice Age.

Florida peninsula was covered by a sea. This fact is recorded at the present time in limestone found near the surface in the Ocala area. Remains of ancient marine animals make up the bulk of this Ocala limestone. Since limestone is soluble in water containing acids, large holes have been dissolved in this limestone formation by the action of acidified water during the past millions of years. Another layer of less soluble material was deposited during the Miocene epoch. This is called the Hawthorne formation. It is found beneath the surface resting on the eastern edge of the Ocala limestone and extending to the St. Johns River.

Since Eocene times, layers of material of marine origin have been deposited over the Ocala limestone. MacNeil[2] and Vernon[3] present profile diagrams of formations under the surface of Florida. While at Ocala the limestone is near the surface, there is a trend as it extends southward to slant more deeply into the earth. These profiles also show an increasing number of layers above the Ocala limestone toward the southern end of the peninsula. A red clay-sand mixture is prominent among the many layers of material deposited over the Ocala limestone. It occurs near the surface

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[2] F. S. MacNeil, Pleistocene Shore Lines in Florida and Georgia, U. S. Geological Survey Professional Paper No. 221-F (Washington: U. S. Government Printing Office, 1950), pp. 95-107.

[3] R. O. Vernon, Geology of Citrus and Levy Counties, Florida (Florida Geological Surv. Bull. 33, 1951), pp. 1-256.

in the southern lake region, and it is used in constructing side roads in this area. This red material is similar to the Citronelle formation found in southern Alabama and western Florida. The latter material was deposited during the Pliocene epoch.

Knowledge of the epochs through the Pliocene has been gained by an examination of well drillings, a classification of fossil animals found in the old rocks, and a study of formations occurring near the surface. Pleistocene material occurs above older formations, and it has been studied more completely than have other formations. This epoch was the most important time in the shaping of the present land area of Florida.

The Pleistocene epoch is synonomous with the Ice Age. Over a period of about 1,000,000 years sheets of ice moved down into the Northern United States, Central Europe, and Central Asia. Modern geologists recognize four distinct glacial stages in the United States. They were the Nebraskan, Kansan, Illinoian, and Wisconsin stages from the oldest to the most recent. Each of these glacial stages withdrew with the advent of warmer weather melting the ice. These interglacial stages were the Aftonian, Yarmouth, Sagamon, and Mid-Wisconsin. The last warm period is known as a post glacial stage (see Table 2 for a correlation of glacial and interglacial stages).

Flint estimates that during the period of maximum glaciation over 30 per cent of the present land area of the

TABLE 2[a]

RELATIONSHIPS OF RELIC SHORE LINES TO GLACIAL AND INTERGLACIAL STAGES

EPOCH	GLACIAL STAGE	INTERGLACIAL STAGE	RELIC SHORE LINE	SHORE LINE ELEVATION IN FEET ABOVE PRESENT SEA LEVEL
PLEISTOCENE		Post-Wisconsin	Silver Bluff	8-10
	Wisconsin			
		Mid-Wisconsin	Pamlico	25-35
		Sangamon (120,000 years duration)	Wisconsin	100
	Illinoian			
		Yarmouth (300,000 years duration)	Okefenokee	150
	Kansan			
		Aftonian (200,000 years duration)	Coharie	215
		Nebraskan		
PLIOCENE		Pre-glacial	Brandywine	265

[a]Compiled from information presented by F. S. MacNeil, Pleistocene Shore Lines in Florida and Georgia, and by C. W. Cooke, Geology of Florida.

world was covered with ice. From recent evidence in Greenland it is assumed that Pleistocene ice sheets were often more than 2,000 feet thick.[4] When large portions of these glaciers melted, the sea level was changed. During the four glacial stages and the related interglacial stages the sea level fluctuated hundreds of feet. Since the highest land elevation in Florida is about 325 feet above present sea level, and most of the state is below 150 feet elevation, Pleistocene fluctuations of sea level resulted in an alternate flooding and emerging of parts of what is now the peninsula.

Interglacial stages resulted in sea levels above the present one. The duration of the interglacial sea levels was estimated by Daly to be hundreds of thousands of years.[5]

As the sea level rose, deposits of sand were made over the earlier formations. Shore lines in sandy areas are characterized by several features. First, wave action cuts the shore. Second, if ocean currents move sand toward or parallel to the shore, sand bars are formed. Wave action contributes to bar formation. A third characteristic is the formation of dunes by wind-blown sand. A sorting of sand grains occurs when they are transported by water or wind.

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[4]Flint, op. cit., p. 35.

[5]R. A. Daly, The Changing World of the Ice Age, (New Haven: Yale University Press, 1934), p. 37.

This means that sand dunes and sand bars are made up of particles relatively uniform in size.

Cooke[6] and MacNeil[7] maintain that old shore lines formed by these interglacial seas can be identified in Florida. Cooke named seven distinct shore lines. He correlated two of them, the Pamlico and the Wicomico, with similar formations that extend into Virginia. Flint agreed with Cooke on these two, although Flint assigned different names.[8] Cooke established the seven shore lines by a combination of methods. He examined geological survey maps for shore-like features. He also examined these areas in the field. He detected remnants of old shore lines by the presence of relic cuts, dunes, and sand bars.

MacNeil recognized four distinct former shore lines. They either corresponded with, or were similar to Cooke's shore lines at related elevations.[9] This difference in opinion regarding the number of shore lines serves to emphasize the difficulty in establishing definite correlations between relic shores and interglacial stages. MacNeil pointed out

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[6]C. W. Cooke, "Seven Coastal Terraces in the Southeastern States," Washington Academy Scientific Journal, XXI (1931), 503-513.

[7]MacNeil, loc. cit.

[8]F. R. Flint, "Discussion," American Scientific Journal, CCXXXIX (1940), 459.

[9]MacNeil, loc. cit.

that numerous intermediate shore lines could have been formed by short stable periods during a recession of the sea.[10]

Sea level is affected by forces other than the addition or subtraction of water. The weight of ice sheets present during the Pleistocene was enough to cause the underlying earth crust to sag. To compensate for this tremendous weight of water removed from the oceans, the ocean floors were pushed up a distance roughly equivalent to the sag in the land. Another factor was the mean temperature of the ocean. If the temperature of the existing oceans was increased by ten degrees C. the water level would rise more than ten feet. Tilting of coast lines alters the original position of former shores in relation to the present sea level. There is some evidence that the Pacific Coast of the United States has risen many feet above the present sea level. There is disagreement among geologists concerning the tilting of the Atlantic Coast. Cooke concluded from his work that there is no evidence of tilting.[11] There is no evidence of great changes in position of the southeastern Atlantic coast of the United States. However, the fact remains that relative changes in position of large land masses any place in the world will influence the sea level everywhere.

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[10] Ibid.

[11] C. W. Cooke, "Pleistocene Seashores," Washington Academy Scientific Journal, XX (1930), 389-395.

Material is presented in a table correlating Pleistocene events and former shore lines (see Table 2).

Each shore line is associated with a terrace. The terrace was formed by the leveling action of the water as it stood at a constant elevation. Cooke[12] and MacNeil[13] suggested that during each succeeding interglacial stage the rising sea halted at a lower level. This sequence would tend to protect older shore lines from drastic changes. An idealized profile of a Florida shore and terrace sequence is presented in Figure 1. Figures 2, 3, and 4 illustrate former shore lines of glacial and interglacial stages, in relation to the present shore lines of Florida.[14] The positive values represent interglacial periods above the present sea level. Negative values represent glacial periods below the present sea level.

Florida is now covered by a mantle of sand. The influence of fluctuations in sea level is evidenced by the occurrence of water sorted sand bars and wind sorted dunes from one end of the state to the other. The only visible influence of the Eocene formation is the presence of lakes

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[12] C. W. Cooke, "Geology of Florida," Florida Geological Survey Bulletin No. 29, (1945).

[13] MacNeil, loc. cit.

[14] Ibid. These figures are interpretations made from a composite map presented by MacNeil.

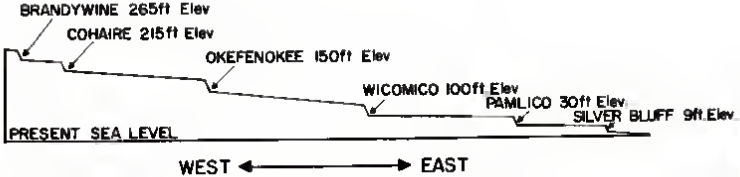

FIGURE 1

IDEALIZED PROFILE OF FLORIDA PENINSULA SHOWING PLEISTOCENE MARINE TERRACES.

ic the central part of the state. Vernon,[15] Penneman,[16] and Laessle[17] state that the process of solution in the Ocala limestone caused a sinking which resulted in the hundreds of lakes.

Less than 20,000 years have elapsed since the last glacial stage. Many of the old shore lines can be observed today because of the presence of the white sand deposits still in dune form. Some plant communities included in this study occur in these areas.

Soil Types

Two types of soils are important to the study of the plant communities included in this work. The St. Lucy series of soils is characterized by a white sand from a few to many feet deep. St. Lucy soils are associated with old shore lines and sand dunes. The Lakeland series is characterized by a few inches of a gray surface layer and a lower layer several feet thick of yellow sand. The red Citronelle-like formation underlies the yellow sand. The two soils are often found in adjacent areas.

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[15] Vernon, loc. cit.

[16] E. M. Penneman, Physiography of Eastern United States (New York: McGraw-Hill Book Co., 1938), p. 53.

[17] Albert M. Laessle, "The Origin and Successional Relationship of Sandhill Vegetation and Sand-Pine Scrub," Ecological Monographs, Vol. XXVIII, n. 4, (October 1958), pp. 361-387.

Miller made an analysis of the two soil types.[18] Both soils demonstrated a high degree of uniformity in particle size. They both consisted of about 70 per cent fine sand. Neither soil contained much organic matter. The Lakeland series contained 0.62 per cent organic matter to 0.06 per cent for the St. Lucy series in the top three inches of soil. Even with this similarity the two soils supported a different type of plant community.

More research must be completed before the critical factors that control plant distribution on these soils is discovered.

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[18] R. B. Miller, "Ecological Comparisons of Plant Communities of the Xeric, Pine Type on Sand Ridges in Central Florida" (unpublished Master's thesis, University of Florida, 1950), pp. 21, 28.

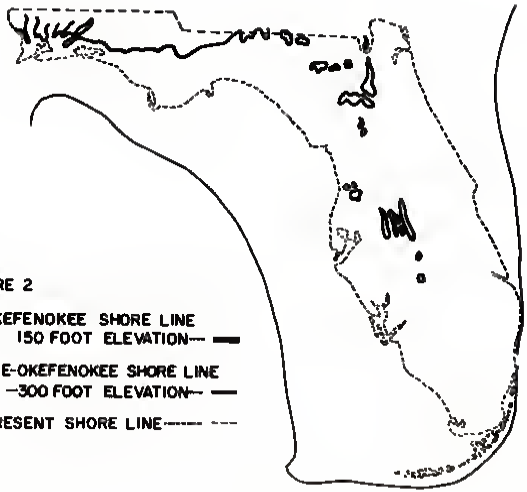
FIGURE 2
OKEFENOKEE SHORE LINE
150 FOOT ELEVATION
PRE-OKEFENOKEE SHORE LINE
-300 FOOT ELEVATION
PRESENT SHORE LINE

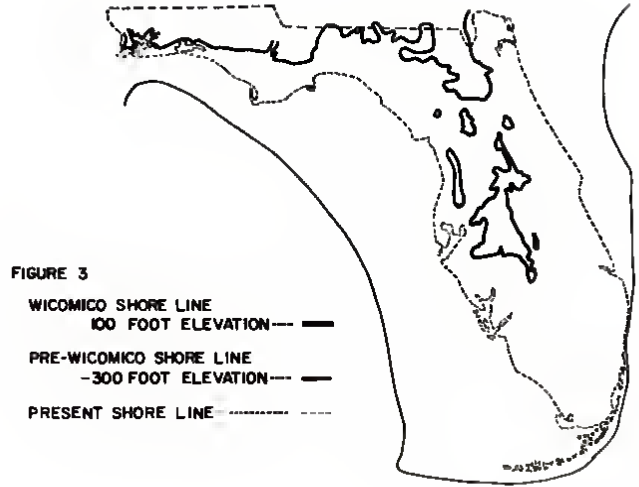
FIGURE 3
WICOMICO SHORE LINE
100 FOOT ELEVATION
PRE-WICOMICO SHORE LINE
-300 FOOT ELEVATION
PRESENT SHORE LINE

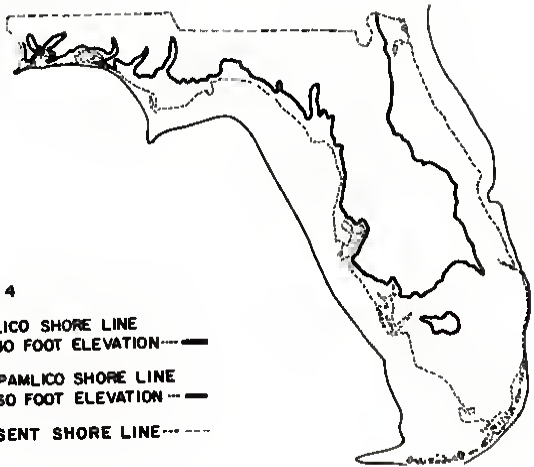

FIGURE 4

PAMLICO SHORE LINE
30 FOOT ELEVATION

PRE-PAMLICO SHORE LINE
-60 FOOT ELEVATION

PRESENT SHORE LINE

CHAPTER III

FINDINGS

Nature of a Plant Community

If a person should ride through sections of Florida with the intent of inspecting the shrubs and trees that line the route, he would soon be able to recognize different groupings of these plants. It would seem that certain patterns would occur in various parts of the state and that these patterns would be repeated over and over again.

Upon more careful examination it could be found that there are a few plants, usually shrubs and trees, growing together in a similar environmental situation. This combination of plants and additional environmental condition may occur in almost any part of the state, and can be referred to as a plant community. As explained in chapter one, a plant community is usually named by selecting the names of the most common conspicuous plant or combination of plants. Their names are then used to designate a particular type of vegetational arrangement. For example, a very common tree combination found in Florida is longleaf pine and turkey oak. The plant names are combined to produce the name of the plant community, Longleaf-pine/Turkey-oak. This

community will consist of many different plants, some of which will be more numerous but each smaller than longleaf pines and turkey oaks. However, since the pines and oaks are the largest and most easily observed their names are used to label a complex arrangement of plant life made up of a large number of individual kinds.

Specific Plant Communities

There are five distinct types of plant communities used in this study as examples, and their more obvious characteristics are pointed out.

The plant community on active sand dunes

Sea Otte Community. The most conspicuous and dominant plant on an active dune is sea oats, Uniola paniculata. This plant is the most common of the active dune stabilizing plants in Florida and it grows best under circumstances of shifting sand. Other plants that usually make up the active dune plant community are panic grass, Panicum spp., cord grass, Spartina spp., railroad vines, Ipomoea spp., sea elder, Iva imbricata, and sea rocket, Cakile edentula. Shrubs and trees are found in this community only when the shore line is encroaching upon the land or for some reason a stabilized dune becomes active.

The soil that supports this community is fine wind-blown sand. As mentioned above, the soil may be moved continually from a constant wind blowing in from the water. If

the wind shifts the direction of movement of the sand also will be influenced. Active sand dunes will have the appearance of freshly distributed sand and occur in locations adjacent to the stabilized dune communities. It should be noted that these active dunes will be those nearest the shore line. In some areas there will be only one active dune line with all dunes behind it being stable.

Plant communities on the active sand dunes can be recognized by: (1) The presence of sea oats as the dominant plant, (2) The occurrence of other grasses, vines, and succulent herbs in patches, (3) Disturbed appearance of the sand, (4) Soil condition of extreme dryness, except for the ocean spray.

Stabilized dune plant communities

Plants making up the communities on stabilized dunes have one characteristic in common. They all have a high degree of resistance to adverse conditions produced by wind, salt spray, and desiccation. The vegetation on stable dunes nearest the shore line is normally dominated by evergreen and perennial grasses. The most common ones are sea oats, Uniola paniculata, saltmeadow cordgrass, Spartina patens, panic grass, Panicum amarum and Panicum amarulum. Next in order of importance are a few perennial plants such as two species of railroad vine, Ipomoea littoralis and Ipomoea pes-caprae, golden aster, Heterotheca subaxillaris, sea elder, Iva imbricata, and evening primrose, Oenothera

humifusa. In peninsula Florida the most common woody plants are scrub oaks, Q. maritima, Q. myrtifolia and some yaupon, Ilex vomitoria. In west Florida bush goldenrod, Chrysomoma pauciflosculosa, and dwarf magnolia, Magnolia grandiflora are frequently found. Sand pine occurs on the older dunes along the north Gulf Coast.

The soil is made up entirely of wind-blown sand with little or no organic matter. The soil is well drained, and it consists of a dry surface layer and a damp layer beneath. Large amounts of moisture from frequent rainfall collect in the swales.

These dune plant communities are found along the Atlantic Coast except in the Florida Keys, along the peninsula Gulf Coast approximately from Naples to Tarpon Springs, and from Alligator Harbor westward.

The identifying characteristics of a stabilized dune plant community are: (1) Accumulations of wind-blown sand in dunes covered and held in place by grasses and a few herbs and shrubs, (2) The distribution of plants by zones, the most resistant plants near the shore followed by the zones of shrubs and trees of less resistant members, (3) The severe climatic factors of wind, salt spray, and desiccation producing "wind sheared" shrubs, (4) The soil composition of sand containing little or no organic matter.

Oak Hammock Community

Only one of the community surveys made in this study contains material from a typical oak hammock.

The large oaks are usually the dominant trees in these communities in Florida, but there are often several other trees, usually hardwoods, that share in the dominance in areas around the state. Live oak, Q. virginiana, and laurel oak, Q. laurifolia, are the usual oaks present. Magnolia, Magnolia grandiflora, red bay, Persea borbonia, wild olive, Osmanthus americana, and red cedar, Juniperus silicicola, are trees that occur in smaller numbers in hammocks across north Florida from the Atlantic Ocean into Escambia County.

Shrubs will usually include yaupon, Ilex vomitoria, beauty berry, Callicarpa americana, and numerous other species.

Herbs and vines of many species are normally present in these hammocks. Most of the herbaceous plants are seasonal while the ferns are evergreen in protected areas. The most common vines occurring in this community are bamboo vine, Smilax sp., blackberry, Rubus sp., poison ivy, Rhus toxicodendron, wild grape, Vitis spp., and Virginia creeper, Ampelopsis quinquefolia.

Ground cover usually consists of a thick mat of leaves with a layer of organic debris on the soil surface.

The soil is often composed of the same fine sand that makes up the Lakewood and Lakeland soil series. However,

the organic content is greater and thus the moisture holding capacity of the soil is much better than that found in either of the two previously described communities.

The cover provided by the oaks and other hardwoods creates a dense shade near ground level. This permits the growth of those plants that are shade tolerant and also tends to prevent rapid evaporation of water from the soil.

The distribution of oak hammock communities in Florida is less common than most other community types. There is not as much total area covered by this type, since its occurrence depends upon a mature soil with at least a moderate amount of incorporated organic matter and a moderate yearly soil moisture supply. These communities can usually be found even in the dryer parts of Florida if there is some drainage area between hills. Many of the smaller streams in Florida are bordered by this community type.

Some identifying characteristics of the oak hammock community are: (1) The dominance of live and laurel oaks, (2) A complement of other hardwoods, (3) The occasional formation or a dense shrub undergrowth, (4) The presence of plants mostly of the seaboard type, (5) Limitation of shrubs and herbs to shade tolerant species, (6) The covering of soil with a thick layer of leaves and decaying organic material, (7) The soil composition of fine sand with from moderate to high organic content, (8) A yearly moisture supply ranging from moderate to high.

Sand-Pine Scrub

Sand pine, Pinus clausa, is the dominant tree of this community. Myrtle oak, Q. myrtifolia, Chapman oak, Q. chapmani, and scrub live oak, Q. maritima, are present in large numbers. The relative frequency of each of these trees will vary from one location to the next. Important shrubs that may be found in this community are rosemary, Ceratiola ericoides, and crooked-wood, Lyonia ferruginea. Small plants that characterize the Sand-Pine Scrub are prickly pear, Opuntia sp., and deer moss lichen, Cladonia spp. These plants can occur in this community wherever it exists in the state. The presence of all of the above plants is not required for this type community to exist. In any given location at least one of these plants may be absent; however, with close inspection one can usually find the plants mentioned in any given sample of Sand-Pine Scrub.

Some species of plants restricted to the Sand-Pine Scrub area occur only in certain sections of the state. For example the scrub palmetto, Sabal etonia, scrub holly, Ilex cumulicola, and sticky leaf, Garberia fruticosa are found only in the scrubs of peninsula Florida. This phenomenon is also true of the other plant communities in Florida. Because of the wide range of climatic and geological factors many species of plants are isolated in small geographical regions of the state.

A soil characteristic of the Sand-Pine Scrub is usually the strikingly white sand of the Lakewood series discussed in chapter two of this study. It can be stated that almost any occurrence of this type of soil other than that of an active shore line, will be supporting a Sand-Pine Scrub. Very little organic matter is present in this soil. However, under heavy vegetation there will be a collection of leaf litter on the surface. Apparently the organic material is oxidized before it can be incorporated with the soil.

Ground cover is usually sparse except in occasional spots where deer moss lichen occurs in large quantities.

With the combination of soil type, almost pure white sand, and the lack of much ground cover, the moisture conditions found in the scrub communities are unfavorable for rapid growth. It can be said that the soil is always well drained and the surface layer is very dry, in spite of the high annual rainfall in Florida.

Occurrence of the Sand-Pine Scrub Community in the state is associated with shore line deposits of the wind and water sorted white sands. As pointed out in chapter two these deposits occur in the center of the peninsula and at intervals toward the coastlines in places that correspond to the various relic shore lines of the Pleistocene period. The oldest scrub areas are in the Ocala National forest and scattered along the central ridge of Florida from near the Georgia state line south to the Archbold Biological Station

near Lake Placid. Remnants of relic dune lines and off-shore sand bars can be seen often in Polk and Highland counties where the ridge comes to an end. Scrub vegetation is associated with these old shore lines throughout Florida. Scrub vegetation occurs on relatively young stabilized dunes especially on the north Gulf of Mexico shore line. In some areas along the Gulf, sand pine grows on the back slope of the first stabilized dune.

The identifying characteristics of the Sand-Pine Scrub are: (1) The presence of sand pine as the dominant tree, (2) The occurrence of heavy shrub growth of oaks and often rosemary, (3) A light ground cover mostly of deer moss lichen, (4) Usually white sand deposits of wind and water sorted origins, (5) Conditions of severe dryness, (6) an evergreen indicator vegetation.

Longleaf-Pine/Turkey-Oak Community

This community is named for the ten dominant kinds of trees that occur in the sand hill regions of Florida. Longleaf pine, Pinus palustris, and turkey oak, Quercus laevis, occur in this community combination from the southern ridge area to locations in north Florida and west Florida extending into Escambia County.

The most consistent herbaceous ground cover is wire grasses of different species, Aristida stricta and Sporobolus gracilis. These plants may provide a very heavy cover in some areas while in other areas they may be present

in occasional turfs. This latter condition is often found in central Florida where the Longleaf-Pine/Turkey-Oak Community lies adjacent to a Sand-Pine Scrub Community. Deer moss lichen is often present in the more sparsely covered Longleaf-Pine/Turkey-Oak Communities.

A small plant that is usually present in this community is the gopher apple, Chrysobalanus oblanqifolius. Its average height is from one to two decimeters. This plant usually occurs in small patches of two or three meters in diameter in areas where there is little other ground cover.

Soil types that support the Longleaf-Pine/Turkey-Oak Community belong to the Lakeland Series. They are most often characterized by a light colored upper layer of sand from two to ten centimeters deep above a layer of yellow sand, usually several meters deep. Beneath the yellow sand is a hard red clayey sand deposit known as the "citronelle" formation. The texture of the soil is that of fine sand with very little if any organic matter incorporated.[1]

There is a variation in the amount of moisture in these soils. With a heavy ground cover of wire grasses, moisture content appears to be higher than where ground cover is very sparse.

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[1] R. B. Miller, "Ecological Comparisons of Plant Communities of the Xeric, Pine Type on Sand Ridges in Central Florida" (unpublished Master's thesis, University of Florida, 1950), p. 28.

The occurrence of Longleaf-Pine/Turkey-Oak Communities in Florida is extensive. This community type is normally found in the sand hill[2] or lake region of the peninsula and on smaller ridges toward both coast lines. In the western part of Florida this community type is the most common one on the higher land formations. With respect to elevation, the Longleaf-Pine/Turkey-Oak Community is often found above and below Sand-Pine Scrub areas. What is now the Lakeland soil series may have formed the islands in Pleistocene seas. The shore lines formed around them leaving the white sand deposits now supporting the Sand-Pine Scrubs.

Some of the prominent identifying characteristics of the Longleaf-Pine/Turkey-Oak Community are: (1) The occurrence of longleaf pine and turkey oaks as the dominant trees, (2) The inclusion of gopher apples among the shrubs, (3) The presence of a ground cover consisting of wire grass with the addition of deer moss lichen in the dryer areas, (4) The support of vegetation by the well drained yellow Lakeland soil series, (5) During fall and winter the leaves of the turkey oak turn red and then brown. These dead leaves are persistent through the winter.

One comment concerning the features of this type plant community in Florida should be made. Even though this type

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[2]Albert M. Lasseter, "The Origin and Successional Relationship of Sandhill Vegetation and Sand-Pine Scrub," Ecological Monographs, Vol. XXVIII, no. 4, (October 1958), pp. 361-387.

of community is probably one of the more extensive ones in the state, thousands of acres of it are being cleared yearly. The soil type that supports it makes up the prime citrus land in central Florida, and in west Florida it is of increasing value as land for reforestation with slash pine.

Samples of Vegetational Communities

Sampling technique

The following tables and observations were designed to serve two functions. First, they provide lists of most of the dominant plants found in the plant communities discussed in this work. Second, the methods used to compile this information are those that can be employed by teachers and students in their studies of plant communities.

In the study of vegetation one can make observations and form mental pictures of the types of plants that make up a forest or a field. An idea of the fertility of the soil can be gained by inspection. The effects of some previous or present condition altering the patterns of vegetation can be seen. For a better understanding of plant distribution and growth, some methods for studying biological relationships found in plant communities are demonstrated.

Since the greatest value is derived by studying living specimens in their natural habitat, information in this chapter was taken directly from the field and prepared in a

form that could be used as a guide for the study of the same or similar plant communities.

Teachers and students will gain most from field work by making accurate records of their measurements and observations. Careful planning for additional investigation will provide the maximum value of a study of plant communities.

All of the community samplings included in this chapter were taken by means of the transect technique. A transect is a segment of land two meters wide and a selected number of meters long. Plants growing within this area are recorded by the presence of each species, and, if desired, the number of each species in each transect.

Plants occurring in frequencies of less than 50 per cent, found in less than half of the transects taken in an area, were omitted. This was done in order to shorten the plant lists; however, these plants may be included if a detailed, long range study is contemplated.

The symbols used in the following plant lists are "P" for presence in a transect and "O" for absence in a transect. In most lists the dominant plants were recorded by the number of individuals in each transect. Transects were employed to demonstrate the presence of typical plants for each of the areas presented, except one. This one was Fort Clinch State Park. In this one vegetational analysis, transects were used to show the transition of community types, from a shore line into an oak hammock. Thus only three transects were made.

Most plant names used in this work were listed as found in the revised edition of Florida Wild Flowers by Mary Francis Baker. Some additional flowering plant names were taken from the Manual of the Southeastern Flora by J. K. Small. Names of trees not found in Baker were taken from the revised edition of The Native Trees of Florida by Erdman West and Lillian E. Arnold. Grasses were named according to the Manual of the Grass of the United States by A. S. Hitchcock. The ferns and other lower vascular plants were listed as found in Ferns of the Southeast by J. K. Small.

Findings

The following tables and observations were compiled from information gathered by the sampling techniques described and are presented to demonstrate a method of acquiring information about plant communities, to present actual analysis of the communities described in this study, and to give some additional information about the particular locations used as demonstration areas.

TABLE 3

PLANT COMMUNITIES AND THEIR PRINCIPAL SPECIES ALONG TRANSECTS FROM SHORE LINE INTO OAK HAMMOCK AT FORT CLINCH STATE PARK

Plant Communities	Species		Presence or Absence Along Transects[a]		
	Scientific Names	Common names	1	2	3
Sea Oat Community. Low dunes were present from the beach inland. Most of them were from 1 to 2 meters high and stable. This community ended in transects 1, 2, and 3; 60, 40, and 150 meters respectively from the shore line.	Shrubs				
	Yucca aloifolia	Spanish bayonet	O	X	X
	Bumelia tenax	Buckthorn	X	X	O
	Herbs				
	Uniola paniculata	Sea oats	X	X	X
	Sporobolus virginicus	Sporobolus	X	X	O
	Spartina patens	Saltmeadow cordgrass	X	X	X
	Panicum amarulum	Panic grass	X	O	X
	Smilax sp.	Greenbrier	O	O	X
	Rumex hastatulus	Sorrel	X	X	O
	Croton punctatus	Croton	X	X	X
	Opuntia sp.	Prickly pear	X	O	X
	Hydrocotyle bonariensis	Pennywort	X	X	X
	Ipomoea littoralis	White railroad vine	X	X	X
	Ipomoea pes-caprae	Purple railroad vine	X	O	X
	Lippia nodiflora	Frog-fruit	O	O	X
	Iva imbricata	Sea elder	O	X	X
	Heterotheca subaxillaris	Golden aster	X	X	X

[a] X denotes presence of a plant species.
O denotes absence of a plant species.

TABLE 3-Continued

Plant Communities	Species		Presence or Absence Along Transects		
	Scientific Names	Common Names	1	2	3
Grass flat. This type of community occurred in transect 3 only. Sporobolus was the dominant plant. There was a depression at 370 meters that contained water during wet periods. This community ended 390 meters from shore line in transect 3.	Trees and Shrubs				
	Juniperus silicicola	Red cedar	0	0	X
	Myrica cerifera	Wax myrtle	0	0	X
	Salix longipes	Willow	0	0	X
	Persea littoralis	Shore bay	0	0	X
	Herbs				
	Sporobolus virginicus	Sporobolus	0	0	X
	Spartina patens	Saltmeadow cordgrass	0	0	X
	Cenchrus sp.	Sandspur	0	0	X
	Dichromena latifolia	White top	0	0	X
	Juncus megacephalus	Rush	0	0	X
	Ampelopsis arborea	Pepper-vine	0	0	X
	Opuntia sp.	Prickly pear	0	0	X
	Sabbatia stellaris	Marsh pink	0	0	X
	Lonicera sempervirens	Coral honeysuckle	0	0	X
	Heterotheca subaxillaris	Golden aster	0	0	X

TABLE 3--Continued

Plant Communities	Species		Presence or Absence Along Transects		
	Scientific Names	Common Names	1	2	3
Community on front slope and crest of the relic dunes. This area contained large expanses of blowouts and active dunes. This was especially true of transect 3. Exposed vegetation was dwarfed and wind-shaped. End of community occurred 110 meters from shore line in transect 1, 75 meters in transect 2, and 630 meters in transect 3.	Trees and Shrubs				
	Juniperus silicicola	Red cedar	X	X	X
	Pinus Elliottii	Slash pine	O	O	X
	Sabal palmetto	Cabbage palm	O	X	X
	Quercus laurifolia	Laurel oak	O	X	O
	Quercus virginiana	Live oak	X	X	X
	Quercus geminata	Scrub live oak	O	O	X
	Myrica cerifera	Wax myrtle	O	X	X
	Toxosa litteralis	Shore bay	X	X	X
	Bumelia tenax	Buckthorn	O	X	X
	Callicarpa americana	Beautyberry	O	X	X
	Herbs				
	Uniola paniculata	Sea oats	X	O	X
	Smilax sp.	Greenbriar	O	X	X
	Vitis sp.	Wild grape	X	X	X
	Ampelopsis quinquefolia	Virginia creeper	X	X	O
	Opuntia sp.	Prickly pear	O	X	X
	Oenothera humifusa	Evening primrose	X	X	X
	Hydrocotyle bonariensis	Pennywort	X	X	X
	Lonicera sempervirens	Coral honeysuckle	X	X	X
	Heterotheca subaxillaris	Golden aster	O	X	X

TABLE 3-Continued

Plant Communities	Species		Presence or Absence Along Transects		
	Scientific Names	Common Names	1	2	3
Community on back slope of large dune ridge. This area was characterized by the movement of sand down into the hammock. End of community occurred 130 meters in transect 1, 90 meters in transect 2, and 644 meters in transect 3.	Trees				
	Juniperus silicicola	Red cedar	X	X	0
	Quercus virginiana	Live oak	X	X	X
	Persea littoralis	Shore bay	X	X	0
	Osmanthus americana	Wild olive	X	X	X
	Shrubs				
	Myrica cerifera	Wax myrtle	0	0	X
	Asimina parviflora	Papaw	X	0	0
	Ilex vomitoria	Yaupon	X	X	0
	Callicarpa americana	Beautyberry	X	X	0
	Herbs				
	Marginaria polypodioides	Resurrection fern	X	0	0
	Asplenium platyneuron	Ebony-spleenwort	X	X	0
	Smilax sp.	Greenbriar	X	X	X
	Berchemia scandens	Rattan-vine	0	0	X
	Vitis sp.	Wild grape	0	X	X
	Ampelopsis arborea	Pepper-vine	0	X	X
	Ampelopsis quinquefolia	Virginia creeper	X	X	0
	Hydrocotyle bonariensis	Pennywort	X	X	0
	Lonicera sempervirens	Coral honeysuckle	0	X	0

TABLE 3-Continued

Plant Communities	Species		Presence or Absence Along Transects		
	Scientific Names	Common Names	1	2	3
Oak Hammock This area was thickly covered by vegetation. The soil was white sand covered by a layer of litter. A conspicuous feature of the terrain was the presence of relic dunes stabilized by the dense vegetation. Transects were sited at the paved road 192 meters from the shore line in transect 1, 199 meters in transect 2, and 806 meters in transect 3.	**Trees**				
	Juniperus silicicola	Red cedar	X	X	X
	Pinus Elliottii	Slash pine	O	O	X
	Sabal palmetto	Cabbage palm	X	O	X
	Salix longipes	Willow	O	X	O
	Quercus laurifolia	Laurel oak	O	X	X
	Quercus virginiana	Live oak	X	X	X
	Magnolia grandiflora	Magnolia	O	X	X
	Prunus caroliniana	Cherry laurel	O	O	X
	Acer rubra	Red maple	O	O	X
	Persea littoralis	Shore bay	X	X	X
	Osmanthus americana	Wild olive	X	X	X
	Shrubs				
	Serenoa serrulata	Saw palmetto	X	X	X
	Yucca aloifolia	Spanish bayonet	X	O	O
	Myrica cerifera	wax myrtle	X	X	X
	Asimina parviflora	Papaw	X	X	X
	Xanthoxylon clava-herculis	Prickly ash	X	X	X
	Rhus copallina	Sumac	X	X	X
	Ilex vomitoria	Yaupon	X	X	X
	Batodendron arboreum	Sparkleberry	X	X	X
	Callicarpa americana	Beautyberry	X	X	X
	Sambucus Simpsonii	Elderberry	O	X	X
	Baccharis halimifolia	Sea myrtle	O	X	X

TABLE 3-Continued

Plant Communities	Species		Presence or Absence Along Transects		
	Scientific Names	Common Names	1	2	3
Oak Hammock continued.	Herbs				
	Nephrolepis exaltata	Boston fern	X	X	X
	Asplenium platyneuron	Ebony-spleenwort	X	O	O
	Pteris latiuscula	Bracken fern	O	X	O
	Smilax SP.	Greenbrier	X	X	X
	Rubus SP.	Blackberry	O	X	O
	Rhus toxicodendron	Poison ivy	X	X	X
	Vitis SP.	Wild grape	X	X	X
	Ampelopsis arborea	Pepper-vine	X	O	X
	Ampelopsis quinquefolia	Virginia creeper	X	X	X
	Hydrocotyle bonariensis	Pennywort	X	O	O
	Lonicera sempervirens	Coral honeysuckle	X	X	O

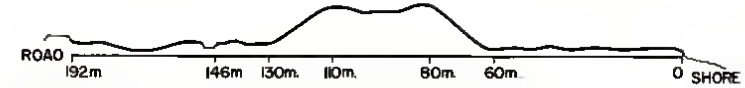
Comments on transects taken in Fort Clinch State Park

Transect 1.--This transect was 2 meters by 192 meters. The first part consisted of low dunes which demonstrated mostly stabilized mounds moderately covered by vegetation and from one to two meters high. The next portion of the transect covered the face and crest of the large dune formation which was 15 to 20 meters above the beach head. This portion was characterized by steep incline covered with dwarfed shrubs and trees. There were occasional blowouts in this area that were 50 or more meters across. The dune back slope was characterized by its invasion into the hammock below. There were numerous shrubs and trees being covered by this creeping sand. The hammock was typical of that vegetational type. Trees and shrubs were in dense populations but the herbs were occasional. There was a drainage ditch at 146 meters. The paved road occurred at 192 meters.

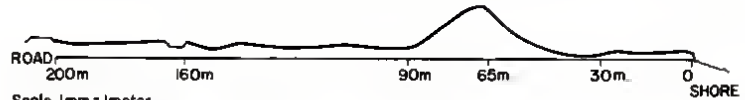
Transect 2.--Transect 2 was taken 40 meters south of transect 1. The low dunes were identical to those in the first transect. The face of the high ridge was much more disfigured and larger than in the first transect. The crest was just a few meters across. The back slope was identical to that in the first transect. Soil in the hammock was the same as that found in the first transect. It consisted of fine white sand covered by from 5 to 10 centimeters of litter. A ditch occurred at 160 meters and the paved road at 199 meters.

Transect 3.--Transect 3 was taken several hundred meters south of transect 2. The low dune area was similar to that of the two previous transects except for its greater width. This transect contained a 250 meter strip of grass flat. Sporobolus was the dominant plant in the flat, but there were several other herbs present and a few scattered shrubs. There was a depression at the end of the flat. The next 240 meters contained the relic dunes and severely disturbed areas. At the hammock edge the dune ridge was 15 to 20 meters high. Blowouts covered much of this area. There was little vegetation in the area. Within the blowouts were active dunes with typical dune vegetation. The back slope gave the appearance of moving into the hammock more rapidly than in the two previous transects. The hammock vegetation was similar to that found in transects 1 and 2. A most conspicuous feature found in the hammock was the existence of low dunes covered by dense vegetation. These dunes were not noticeable in the first two transects. Soil conditions were the same as previously stated. The paved road occurred at 806 meters.

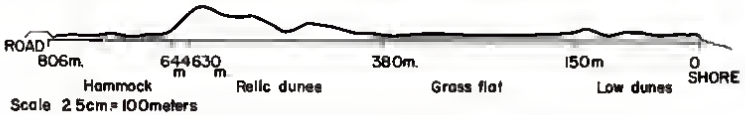
See Figure 5 for a profile of the area covered by the above three transects.



PROFILE OF TRANSECT # 1



PROFILE OF TRANSECT # 2



PROFILE OF TRANSECT # 3

PROFILES OF THE THREE TRANSECTS IN FT. CLINCH STATE PARK.

FIGURE 5

Observations made in the Fort Clinch Area

1. low stable dunes were found near the beach.
2. A dune ridge about 15 to 20 meters in hight was seen behind the low dunes.
3. Large blowouts occurred along the high dune ridge.
4. New active dunes occurred on top of the high dune ridge (see Figure 6).
5. Invasion of the hammock by the high dune ridge was observed (see Figure 7).
6. Relic dunes were conspicuous within the hammock. These were found in various localities throughout the park, but they could most easily be observed in the camping area.
7. Wind-shaped vegetation was present along the dune areas exposed to winds from the ocean.
8. Vegetation successional relationships were found by comparing the plant species and environmental conditions on the different age dunes.
9. Isolated stands of oaks were present in some of the large blowouts.
10. The soil was made up of fine white sand in the dune and hammock areas of the park.
11. The hammock type community can serve as a good source for the illustration of ecological relationships.

Figure 6. New dune activity on top of the relic dune ridge in Fort Clinch State Park.

Figure 7. Invasion of the hammock by active dunes behind the dune ridge in Fort Clinch State Park.

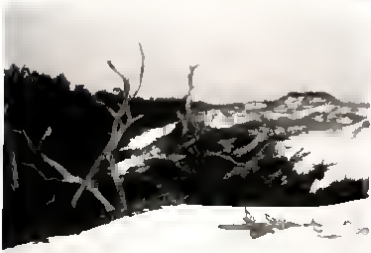


TABLE 4

PLANT COMMUNITIES AND THEIR PRINCIPAL SPECIES ALONG TRANSECTS FROM SHORE LINE TO LAGOON AT ANASTASIA STATE PARK

Plant Communities	Species Names	Transects, 2 meters wide and 20 meters apart[a]									
		1	2	3	4	5	6	7	8	9	10
ZONE 1											
Dune Vegetation Active dunes, blowouts, and washouts.	Uniola paniculata (Sea oats)	X	X	X	X	X	X	X	X	X	X
	Spartina patens (Saltmeadow cord grass)	O	X	O	O	X	X	X	X	X	X
	Panicum amarum (Panic grass)	O	O	X	X	X	O	X	X	X	X
	Cenchrus sp. (Sandspur)	X	X	X	X	X	X	X	X	X	X
	Sesuvium portulacastrum (Sesuvium)	O	X	X	O	X	O	X	O	X	O
	Croton punctatus (Croton)	X	O	X	X	O	O	X	O	X	X
	Oenothera humifusa (Evening primrose)	X	X	X	X	X	X	X	X	X	X
	Hydrocotyle bonariensis (Pennywort)	X	X	X	X	X	X	X	X	X	X
	Ipomoea pes-caprae (Railroad vine)	O	X	O	X	X	X	X	O	O	O

[a]X denotes presence of a plant species
O denotes absence of a plant species

TABLE 4--Continued

Plant Communities	Species Names	Transects, 2 meters wide and 20 meters apart: 1	2	3	4	5	6	7	8	9	10
Dune Vegetation continued	Physalis Elliottii	X	X	X	X	X	0	X	0	X	X
	Heterotheca subaxillaris (Golden aster)	X	0	X	X	X	0	X	0	X	X
ZONE 2 Grass flat Sporobolus is dominant.	Sporobolus virginicus (Blackrush)	0	0	X	X	X	X	X	0	X	X
	Solidago mexicana	X	X	X	X	X	X	X	X	X	X
	Juncus sp.	X	X	X	X	X	X	X	X	X	X
	Borrichia frutescens (Sea ox-eye)	X	X	X	X	X	X	X	X	X	X
ZONE 3 Mangrove Community (within tidal area)	Salicornia perennis[b] (Glasswort)	X	X	X	X	X	X	X	X	X	X
	Batis maritima[b] (Saltwort)	X	X	X	X	X	X	X	X	X	X
	Avicennia nitida (Black mangrove)	X	X	X	X	X	X	X	X	X	XX

[b]These plants occur in zones 2 and 4 but are not dominant.

TABLE 4-Continued

Plant Communities	Species Names	Transects, 2 meters wide and 20 meters apart 1	2	3	4	5	6	7	8	9	10
ZONE 4 Grass Marsh Community (within tidal area)	Spartina alterniflora[c] (Smooth cordgrass)	X	X	X	X	X	X	X	X	X	X

[c]This plant also occurs in the adjacent zone but is not dominant.

Description of vegetational zones covered by transects at Anastasia State Park

Transects of this study were taken from the beach on the Atlantic Ocean across four vegetational zones to the edge of a lagoon. A brief description of each of the zones follows:

Zone 1 - Dune Vegetation

This area consisted of low dunes some of which were stabilized by vegetation and others which were being built or torn down. Plants found in this zone were typical herbaceous beach and dune plants. Uniola paniculata and Hydrocotyle bonariensis were found to be dominant.

Zone 2 - Grass Flat

This strip of vegetation was characterized by a heavy cover of grass, Sporobolus virginicus, which gave the appearance of being a rough lawn. There were occasional plants of Salicornia perennis, Batis maritima, and Avicennia nitida.

Zone 3 - Mangrove Community

This area was within the daily tidal zone. The most conspicuous plant was Avicennia nitida, black mangrove. A solid ground cover was provided by Salicornia perennis and Batis maritima. There were occasional stems of Spartina alterniflora near zone 4.

Zone 4 - Grass Marsh

This zone consisted of an almost pure stand of Spartina alterniflora, smooth cordgrass. There were occasional trees of Avicennia nitida. The marsh was covered at high tide by at least ten or twelve inches of water.

See Figure 8 for a diagrammatic sketch of the four vegetational zones as found in the ten transects taken.

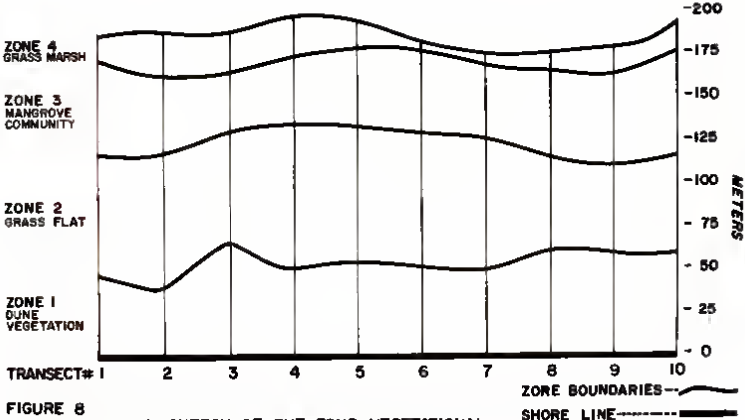


FIGURE 8
DIAGRAMMATIC SKETCH OF THE FOUR VEGETATIONAL ZONES NEAR THE BEACH AT ANASTASIA STATE PARK.

Observations made in the Anastasia State Park Area

1. Observations made in the beach area:
   a. Wind-blown sand and low active dunes are present in the beach area.
   b. Sand was blown into the grass flats (see Figure 9).
   c. Large stable and active dunes occurred about three miles north of the park boundary at St. Augustine Beach. The area just north of the large dunes gave evidence of severe wind erosion. There were very few dunes present in this area (see Figure 10).
   d. Evidence of water flooding the grass flat was found in the form of driftwood and dead grass accumulating around the windward bases of shrubs found there. (see Figure 11).
   e. The Mangrove Community and the grass marsh were covered by water at high tide, at least in part.
   f. The beach within the park was separated from the mainland by a tidal lagoon that extended almost to the southern park boundary at St. Augustine Beach.
2. Observations made in the hammock area:
   a. The vegetation was similar to that found in the Fort Clinch State Park hammock.
   b. Vegetation found on the lagoon was severely wind shaped (see Figure 12).

c. There was some wind and water erosion at the edge of the lagoon.

d. Relic dunes were conspicuous throughout the hammock.

3. Observation made west of St. Augustine along U. S. Highway #1:

Low relic dunes occurred along U. S. Highway #1 north and south of St. Augustine. These dunes were made conspicuous by the presence of sand pine growing on them and soil consisting of white sand.

Figure 9. Wind-blown sand on the grass flat in Anastasia State Park.

Figure 10. Wind erosion of a dune in Anastasia State Park. Sea oats are established on dune. Scale in photograph equals one meter.

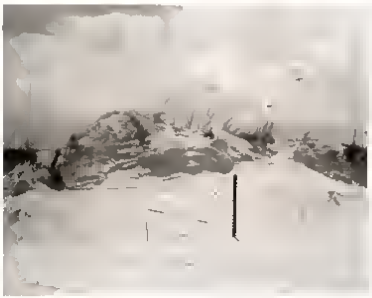


Figure 11. Debris washed and blown around the base of a shrub in the grass flat near the beach in Anastasia State Park. Scale in photograph equals one meter.

Figure 12. Wind-shaped trees at the edge of the hammock in Anastasia State Park.

TABLE 5

PRINCIPAL SPECIES ALONG TRANSECTS IN THE OAK HAMMOCK COMMUNITY AT TOMOKA STATE PARK

Species Names	Transects, 2 meters wide and 20 meters apart[a,b]									
	1	2	3	4	5	6	7	8	9	10
Trees										
Pinus clausa (Sand pine)	0	0	0	0	X	X	X	X	X	X
Sabal palmetto (Cabbage palm)	X	X	X	X	X	X	X	X	X	X
Quercus laurifolia (Laurel oak)	X	X	X	X	X	X	X	X	X	X
Quercus virginiana (Live oak)	X	0	0	0	X	X	X	0	0	X
Ilex opaca (Holly)	X	0	0	X	X	0	0	0	X	X
Persea Borbonia (Red bay)	X	X	X	X	X	X	X	X	X	X

[a]X denotes presence of a plant species.
0 denotes absence of a plant species.

[b]The total length of each transect was as follows: transect 1, 63 meters; transect 2, 67 meters; transect 3, 69 meters; transect 4, 73 meters; transect 5, 84 meters; transect 6, 84 meters; transect 7, 99 meters; transect 8, 124 meters; transect 9, 129 meters, and transect 10, 136 meters.

TABLE 5-Continued

Species Names	Transects, 2 meters wide and 20 meters apart[ab]									
	1	2	3	4	5	6	7	8	9	10
Shrubs										
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	X	X	X	X	X
Ximenia americana (Tallow-wood)	X	X	0	X	X	X	X	X	X	X
Asimina parviflora (Papaw)	X	0	0	0	X	X	X	X	X	X
Ilex vomitoria (Yaupon)	X	X	X	X	0	X	X	X	X	X
Rhododendron arboreum (Sparkleberry)	X	X	X	X	X	X	X	X	X	X
Bumelia tenax (Buckthorn)	0	X	X	0	0	X	0	X	X	X
Callicarpa americana (Beautyberry)	0	0	0	0	X	X	X	X	X	X

TABLE 5--Continued

Species Names	Transects, 2 meters wide and 20 meters apart[ab]									
	1	2	3	4	5	6	7	8	9	10
Herbs and vines										
Mayrisaria polypodioides (Resurrection fern)	X	X	X	X	X	X	X	X	X	X
Phlebodium aureum (Golden polypody)	0	X	X	X	X	0	0	0	X	X
Smilax spp. (Greenbriar)	X	X	X	X	X	X	X	X	X	X
Vitis spp. (Wild grape)	X	X	X	X	X	X	X	X	X	X
Psychotria nudata (Wild coffee)	X	X	X	X	X	0	0	0	0	0

Comments on transects taken in Tomoka State Park

The transects were taken in the park area beginning near the Tomokie monument and extending south. The paved road was used as the base and a power line marked the end of each transect. Parts of the area covered by the transects were populated by dense vegetation. Other sections were thinly populated at ground level but covered by a dense canopy of trees.

The occurrence of Pinus glauca was restricted to the highest ground in the area sampled. This fact was recorded in the transects as higher ground was approached. These trees were found in the center section of each transect from number five through ten.

Observations made in the Tomoka State Park Area

1. Observations made in Tomoka State Park:
   a. The dominant plants in the hammock were Sabal palmetto, Quercus laurifolia, Persea Borbonia, and Pinus glauca.
   b. Vegetation on the high ground consisted of plant varieties that could occur in a Sand Pine Community. These were Pinus glauca, Bumelia tenax, and Serenoa serrulata.
   c. The soil consisted of white sand with about five to ten centimeters of organic matter on the surface.
   d. There was evidence of wind shaping of trees and shrubs on the Halifax River boundary.
   e. Zamia or coonti was observed occasionally in the park area. This plant was used as food by the early Florida Indians. The northern part of the park contained remains of Indian habitation.
2. Observations made in the surrounding area:
   a. A large section of land north of the park on the old highway contained two types of plant communities, hardwood hammock and sand-pine scrub.
   b. Within the same area as described above there occurred vegetation populations intergrade between the sand-pine scrub and hardwood hammock.

TABLE 6

PRINCIPAL SPECIES ALONG TRANSECTS IN THE SAND-PINE SCRUB COMMUNITY AT JONATHAN DICKINSON STATE PARK

Species Names	Transects, 2 meters wide, 100 meters long and 20 meters apart[a]									
	1	2	3	4	5	6	7	8	9	10
Trees										
Pinus clausa (Sand pine)	X	X	X	X	X	X	X	X	X	X
Shrubs										
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	0	X	X	X	X
Quercus Chapmanii (Chapman oak)	X	X	0	X	X	X	X	X	X	X
Quercus myrtifolia (Myrtle oak)	X	X	X	X	X	X	X	X	X	X
Quercus geminata (Scrub live oak)	X	X	X	X	X	X	X	X	X	X
Ximenia americana (Tallow-wood)	X	X	X	X	0	X	X	X	X	X
Garberia ericoides (Rosemary)	X	X	X	X	X	X	X	X	X	X
Opuntia sp. (Prickly pear)	X	X	X	0	X	X	X	X	0	X
Lichens	X	X	X	X	X	X	X	X	X	X

[a] X denotes presence of a plant species.
0 denotes absence of a plant species.

Comments on transects taken in Jonathan Dickinson State Park

The area covered by transects in this park began about 100 meters south of the main entrance and extended south along the fire trail at 20 meter intervals. Apparently the area had not been disturbed except by the creation of a fire trail at the park boundary.

A conspicuous fact concerning the plant population was that of uniformity of a few species of shrubs and sand pine. There were few herbs present in this area.

Observations made in the Jonathan Dickinson State Park Area

1. Observations made in the park, east of the railroad:
   a. The entire area was covered by relic dunes.
   b. The soil consisted of white sand covered with a light litter composed mostly of oak and pine leaves.
   c. There were bare spots in areas where no vegetation and little vegetation existed.
   d. Pinus clausa, sand pine, occurred in dense stands. There were few other trees on the dunes except in disturbed areas where introduced varieties occurred.
   e. There were very few sand pine seedlings.
   f. The adult pine trees were about 15 meters tall and most all were leaning with the prevailing winds (see Figure 13).
   g. The shrubs formed dense thickets about one meter tall under the pine trees. Quercus myrtifolia and Quercus geminata were predominant with Ceratiola ericoides occurring frequently.
   h. Ceratiola ericoides grew in thick stands in open areas. When in occurred under the pines, Ceratiola was not vigorous in growth habit.
   i. There were occasional silvarick plants of Serenoa serrulata, saw palmetto, along with the more common green variety.
   j. There were few herbaceous plants in the undisturbed areas.

k. Lichens of several species were common on the ground and growing from the trees and shrubs.

l. In disturbed parts of the park introduced plants are invading the native scrub. The most important of these invaders are several species of Casuarina, Australian pine.

2. Observations made in the park, west of the railroad:

a. The Sand-Pine Scrub extended to the edge of the flat woods. This flat woods vegetation covered most of the park west of the railroad.

b. A Slash-Pine/Turkey-Oak Community occurred about one fourth mile east of the picnic shelter on the Jupiter River.

3. Observations made in the West Palm Beach area:

The relic dune formations extended up and down the Florida coast for many miles. They were especially prominent in and around Jonathan Dickinson State Park, but they were found from the Fort Lauderdale area to isolated positions north of St. Augustine.

Figure 13. Sand pines in Jonathan Dickinson State Park leaning toward the west.

TABLE 7

PRINCIPAL SPECIES ALONG TRANSECTS IN THE SAND-PINE SCRUB COMMUNITY AT THE ARCHBOLD BIOLOGICAL STATION

Species Names	Transects, 2 meters wide and 100 meters long[a]									
	1	2	3	4	5	6	7	8	9	10
Pinus clausa (Sand pine)	X	X	X	X	X	X	X	X	X	X
Sabal Etonia (Scrub palmetto)	X	X	X	X	X	X	X	X	X	X
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	X	X	X	X	X
Carya floridana (Scrub hickory	X	X	X	X	X	X	X	X	X	X
Quercus Chapmanii (Chapman oak)	X	X	X	X	X	X	X	X	X	X
Quercus laevis (Turkey oak)	X	X	0	X	X	X	X	X	X	X
Quercus myrtifolia (Myrtle oak)	X	X	X	X	X	X	X	X	X	X
Quercus geminata (Sand live oak	X	X	X	X	X	X	X	X	X	X
Asimina obovata (Papaw)	X	X	X	X	X	X	X	X	0	0
Chrysobalanus oblongifolius (Gopher apple)	X	X	X	X	X	X	X	X	X	X
Vitis spa. (Wild grape)	X	X	X	X	X	X	X	X	X	X

[a]X denotes presence of a plant species.
0 denotes absence of a plant species.

TABLE 7-Continued

Species Names	Transects-continued									
	11	12	13	14	15	16	17	18	19	20
Pinus glauca (Sand pine)	X	X	X	X	X	X	X	X	X	X
Sabal Etonia (Scrub palmetto)	X	X	X	X	X	X	X	X	X	X
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	X	X	X	X	X
Carya floridana (Scrub hickory)	X	X	X	X	X	X	X	X	X	X
Quercus Chapmanii (Chapman oak)	X	X	X	X	X	X	X	X	X	X
Quercus laevis (Turkey oak)	0	0	X	X	X	X	0	0	X	X
Quercus myrtifolia (Myrtle oak)	X	X	X	X	X	X	X	X	X	X
Quercus geminata (Sand live oak)	X	X	X	X	X	X	X	X	X	X
Asimina obovata (Papaw)	X	X	X	X	X	0	X	X	X	0
Chrysobalanus oblongifolius (Gopher apple)	X	X	X	X	X	X	X	X	X	X
Vitis sp. (Wild grape)	X	X	X	X	0	0	X	X	X	X

TABLE 7-Continued

Species Names	Transects-continued 1	2	3	4	5	6	7	8	9	10
Opuntia sp. (Prickly pear)	0	0	X	X	X	X	0	0	X	0
Persea humilis (Silk bay)	X	X	X	X	X	X	X	X	0	0
Xylosma ferruginea (Crooked-wood)	X	X	X	X	X	X	X	X	X	X
Vaccinium myrsinites (Blueberry)	X	X	X	X	X	X	X	X	0	0
Palafoxia feayi (Palafoxia)	X	X	X	X	X	X	X	X	X	X
Cladonia sp. (Lichen)	X	X	X	X	X	X	X	X	X	X
Selaginella arenicola (Spike-moss)	0	0	0	0	0	X	X	X	X	X

TABLE 7-Continued

Species Names	Transects-continued									
	11	12	13	14	15	16	17	18	19	20
Opuntia spp. (Prickly pear)	X	X	X	X	X	X	X	X	X	0
Persea humilis (Silk bay)	X	X	0	0	0	0	0	0	0	0
Xolisma ferruginea (Crooked-wood)	X	X	X	X	X	X	X	X	X	X
Vaccinium myrsinites (Blueberry)	X	X	X	X	0	0	X	X	X	X
Paleforia feayi (Paleforia)	X	X	X	X	X	X	X	X	X	X
Cladonia spp. (Lichen) (Deer moss)	X	X	X	X	X	X	X	X	X	X
Selaginella arenicola (Spike moss)	X	X	X	0	X	0	X	X	X	X

Commects on transects taken in the Archbold Biological Station

The Archbold Biological Station is a privately owned facility devoted to biological research and conservation. It is located about three miles southwest of the junction of Highways 27 and 70 in Highlands County. The reason for its inclusion in this study is that the probable southern limit of the Okefenokee shore line included what is now called Red Hill which is the highest point (210 ft.) in the station.[3] The crest of this hill is covered by a Slash-Pine/Turkey-Oak Community. A Sand-Pine Scrub Community surrounds the Slash-Pine/Turkey-Oak Community at a lower elevation.

Transects taken at this station were all situated in the Sand-Pine Scrub. The boundary between the two plant communities was usually indefinite because of an intergrade area of from 50 to 100 meters wide. The transects were taken from several parts of the scrub area in order to obtain a representative sample of the vegetation.

The transects were taken from the following positions using the fire tower at the top of the hill as a reference point:

Transects 1 - 6 were taken from the north section of

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[3]Albert M. Laessle, "The Original Successional Relationship of Sandhill Vegetation and Sand-Pine Scrub," Ecological Monographs, Vol. XVIII, n. 4, (October 1958), p. 371.

the scrub running from the broad fire trail toward the west.

Transects 7 - 8 were taken from the north section of the scrub running from the broad fire trail toward the east.

Transects 9 - 10 were taken in the east section of the scrub starting about 300 meters down the east fire trail.

Transects 11 - 16 were taken in the western part of the scrub starting about 200 meters north of the main gate.

Transects 17 - 20 were taken in the southern section of the scrub beginning behind the pump house of the entrance road.

Additional plants of interest occurring in low frequencies were, Ximenia americana, Bumelia tenax, Ilex cumulicola, and Garberia fruticosa.

Observations made in the Archbold Biological Station and surrounding area

1. Observations in the Archbold Biological Station:

   a. A Slash-Pine/Turkey-Oak Community was on the crest of Red Hill.

   b. A Sand-Pine Scrub Community was located around the base of Red Hill.

   c. Sand-Pine Scrub consisted of dense stands of Pinus clausa in parts, with heavy vegetation beneath the pines.

   d. Plants restricted to sand scrubs of peninsula Florida were found at this location. Some of these were Ilex cumulicola, Carya floridana, Garberia fruticosa, and Selaginella arenicola.

   e. A broad intergrade band of vegetation existed between the two types of plant communities on Red Hill.

   f. Soil type of the Slash-Pine/Turkey-Oak Community was of the yellow sand, Lakeland series. The Sand-Pine Scrub Community was growing on typical white sand of the St. Lucy series.

2. Observations in the southern Highlands County area:

   a. The southern limits of the Ridge were found to be located 2.3 miles to the east of Highway 27 on Highway 70, 5 miles west of Highway 27 on Highway 70, and 6 miles south of Highway 27.

b. Much of the Ridge in this area was covered by Sand-Pine Scrub Communities.

c. There were relic dune ridges at the eastern limit of the Ridge. These can be best observed from aerial photographs maintained by the U. S. Soil Conservation Service office in Sebring.

TABLE 6

PRINCIPAL SPECIES ALONG TRANSECTS IN THE LONGLEAF-PINE/TURKEY-OAK COMMUNITY AT SITE #1, OCALA NATIONAL FOREST

Species Name	Transects, 2 meters wide, 100 meters long, and 20 meters apart[a]									
	1	2	3	4	5	6	7	8	9	10
Trees										
Pinus palustris (Longleaf pine)	X	X	X	X	X	X	X	X	X	X
Quercus laevis (Turkey oak)	X	X	X	X	X	X	X	X	X	X
Shrubs										
Chrysophalanus oblongifolius (Gopher apple)	X	X	X	X	X	O	X	X	X	X
Herbs										
Aristida stricta (Wire grass)	X	X	X	X	X	X	X	X	X	X
Eriogonum tomentosum (Wild buckwheat)	X	X	X	X	X	X	X	X	X	X
Petalostemon sp. (Prairie clover)	X	X	X	O	O	O	O	X	O	X
Croton argyranthemus (Croton)	O	X	X	X	X	X	X	O	O	O

[a] X denotes presence of a plant species.
O denotes absence of a plant species.

TABLE 6--Continued

Species Names	Transects, 2 meters wide, 100 meters long, and 20 meters apart									
	1	2	3	4	5	6	7	8	9	10
Herbs continued										
Opuntia sp. (Prickly pear)	X	X	X	X	X	0	X	X	X	X
Dasystoma pectinata (False foxglove)	X	X	0	X	X	X	X	X	0	X
Chrysopsis graminifolia (Golden aster)	X	X	X	X	X	X	X	X	0	X
Cladonia sp. (Deer moss lichen)	X	X	X	X	X	X	X	X	X	X

Comments on transects taken at Site #1 in Ocala National Forest

This plant community was located 7.2 miles east of Silver Springs on Highway 40. These transects were taken from the north side of the highway near the Florida Forest Service fire tower. The Longleaf-Pine/Turkey-Oak Community occurred both sides of the highway at this point as well as in other areas along Highway 40.

Observations made in Ocala National Forest, Site #1 and the surrounding area

1. The soil type was of the yellow sand Lakeland series. There was little organic cover on the surface.
2. Vegetational ground cover was sparse.
3. The dominant trees were Quercus laevis, turkey oak, and Pinus palustris, longleaf pine. Quercus laevis was much more prevalent than Pinus palustris.
4. There was little evidence of reseeding by Pinus palustris.

TABLE 9

PRINCIPAL SPECIES ALONG TRANSECTS IN THE SAND-PINE SCRUB COMMUNITY AT SITE #2, OCALA NATIONAL FOREST

Species Names	Transects, 2 meters wide, 100 meters long, and 20 meters apart[a]									
	1	2	3	4	5	6	7	8	9	10
Trees										
Pinus clausa (Sand pine)	X	X	X	X	X	X	X	X	X	X
Quercus laevis (Turkey oak)	X	X	0	X	0	X	X	X	X	X
Shrubs										
Sabal Etonia (Scrub palmetto)	X	X	X	X	X	X	X	X	X	X
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	X	X	X	X	X
Quercus Chapmanii (Chapman oak)	X	X	X	X	X	X	X	X	X	X
Quercus myrtifolia (Myrtle oak)	X	X	X	X	X	X	X	X	X	X
Quercus geminata (Scrub live oak)	X	X	X	X	X	X	X	X	X	X
Asimina obovata	X	X	0	0	0	X	X	X	X	X

[a] X denotes presence of plant species.
0 denotes absence of plant species.

TABLE 9-Continued

Species Names	Transects, 2 meters wide, 100 meters long, and 20 meters apart[a]									
	1	2	3	4	5	6	7	8	9	10
Shrubs continued										
Ceratiola ericoides (Rosemary)	X	X	X	X	X	X	0	X	X	X
Opuntia sp. (Prickly pear)	X	X	X	0	0	0	X	0	X	0
Ilex vomitoria (Yaupon)	X	X	X	X	X	X	X	X	X	X
Trees										
Vaccinium myrsinites (Blueberry)	X	X	X	X	X	X	X	X	X	X
Garberia fruticosa (Garberia)	X	X	X	X	X	X	X	X	X	X
Cladonia sp. (Deer moss lichen)	X	X	X	X	X	X	X	X	X	X

Comments on transects taken at Site #2 in Ocala National Forest

The area of investigation was situated 15.3 miles east of Silver Springs on Highway 40. The transects were begun at the stone marker of the Ocala National Game Refuge on the north side of the highway. The vegetation was uniform as to species of plants, but there were small openings in the vegetation covering. These openings were populated with a ground cover, Cladonia sp.

This area was difficult to study because of its dense shrub growth.

Observations in the Sand-Pine Scrub of Ocala National Forest, Site #2 and the surrounding area

1. The transects were taken in an area of mature pine trees.
2. There was a cut-over area on the south side of the highway.
3. Shrubs under the pine trees form dense thickets. The predominant thicket forming plants were Quercus myrtifolia and Quercus geminata.
4. Herbaceous plants were of little significance in the mature Sand-Pine Scrub Communities.
5. The soil was the St. Lucy white sand type. The cover was made up of dead leaves. The open spots were covered by at least two species of Cladonia, deer moss lichen. There were occasional spots of true mosses.
6. A small area had recently been burned west of the stone marker.
7. There was a large burned area 22 miles east of Silver Springs near the entrance of Juniper Springs. The fire occurred several years ago, so the natural reseeding had been well accomplished by the time of this observation.

Figure 14. Sand pines with persistent cones in Ocala National Forest.

TABLE 10

PRINCIPAL SPECIES ALONG TRANSECTS IN THE SHORE LINE PLANT COMMUNITY AT ST. ANDREWS STATE PARK

Species Names	Transects, 2 meters wide and 10 meters apart[b]									
	1	2	3	4	5	6	7	8	9	10
Pinus clausa (Sand pine)	O	O	O	X	X	X	X	X	X	X
Pinus Elliottii (Slash pine)	X	X	X	O	X	O	O	X	O	X
Serenoa serrulata (Saw palmetto)	X	X	X	X	X	X	X	X	X	X
Uniola paniculata (Sea oats)	X	X	X	X	X	X	X	X	X	X
Distichlis spicata (Salt grass)	X	X	X	X	X	X	X	X	X	X
Quercus geminata (Scrub live oak)	X	X	X	X	X	X	X	X	X	X
Quercus myrtifolia (Myrtle oak)	X	X	X	X	X	X	X	X	X	X
Polygonella ciliata	X	X	X	X	X	X	X	X	X	X

[a] X denotes presence of a plant species.
O denotes absence of a plant species.

[b] All transects ended at a wet swale the following distances from the shore line: transect 1, 140 meters; transect 2, 142 meters; transect 3, 146 meters; transect 4, 150 meters; transect 5, 160 meters; transect 6, 165 meters; transect 7, 185 meters; transect 8, 189 meters; transect 9, 202 meters; and transect 10, 206 meters.

TABLE 10-Continued

Species Names	Transects, 2 meters wide and 10 meters apart									sb
	1	2	3	4	5	6	7	8	9	10
Ceratiola ericoides (Rosemary)	X	X	X	X	X	X	X	X	X	X
Ilex glabra (Gallberry)	X	X	X	X	0	0	0	X	0	X
Opuntia sp. (Prickly pear)	X	0	X	X	X	X	X	0	X	X
Aftelia cassioides (Aftelia)	X	0	X	X	X	X	X	X	X	X
Chrysopsis sp. (Goldas astar)	X	X	X	X	X	X	X	X	X	X
Chrysoma pauciflusculosa (Bush goldenrod)	X	X	X	X	X	X	X	X	X	X
Cladonia spp. (Deer moss lichen)	X	X	X	X	X	X	X	X	X	X

Comments on transects taken in St. Andrews State Park

The transects were taken in the dune area west of the large parking lot at the public bath house. The length of each transect was determined by the presence of a wet swale over one hundred meters from the beach.

Three physiographic features were sited in the demonstration location. These were the end of the active dunes, a vehicular trail and the wet swale.

Pinus elliottii, Sarenoa serrulata, and Ilex glabra occurred on the boundary of the swale. These plants were growing in the damp soil and were not found in the dry sandy areas making up most of the study area.

Observations in the St. Andrews State Park Area

1. Observations in the area from the paved road to the shore line. (Within the Park):
   a. Typical stabilized dune formations were present with occasional ponds in the swales between dune lines.
   b. Many of the sand pines on the seaward side of the road were dead. The park superintendent stated that the trees died as a result of storm damage.
   c. Living sand pines were observed to occur much closer to the shore than were observed in localities along the Atlantic coast.
   d. The dunes at the shore were from three to ten meters high.
2. Observations in other park areas and vicinity:
   a. Some of the dune ridges curved away from the shore.
   b. There were a few areas toward Grand Lagoon that were swampy.
   c. Large dune formations outside of the park and along State Highway 392 supported growth of dwarfed magnoliae, Magnolia grandiflora.

St. Andrews State Park is located at the eastern tip of a peninsula forming the western shore of the entrance to St. Andrews Bay. The topography and vegetation of the area are typical of that found along the northern Gulf coast.

TABLE 11

PRINCIPAL SPECIES ALONG TRANSECTS IN THE SHORE LINE PLANT COMMUNITY AT FORT PICKENS STATE PARK

Species Name	Transects, 2 meters wide and 10 meters apart[b]									
	1	2	3	4	5	6	7	8	9	10
Panicum amarulum (Panic grass)	X	X	X	X	O	O	X	X	X	X
Uniola paniculata (Sea oats)	X	X	X	X	X	X	X	X	X	X
Distichlis spicata (Salt grass)	X	X	X	X	X	X	X	X	X	X
Smilax sp. (Greenbrier)	X	X	X	X	X	X	X	X	X	X
Odontophyhla aresta (Nailwort)	X	X	X	X	X	X	X	X	X	X
Cakile edentula (Sea-rocket)	O	X	X	X	X	X	X	X	X	X
Ceratiola ericoides (Rosemary)	X	X	X	X	O	X	X	O	X	X
Crocanthemum arenicola (Frostweed)	X	X	X	X	X	X	X	X	X	X

[a] X denotes presence of a plant species.
O denotes absence of a plant species.

[b] All transects ended at the back of the dune line the following distances from the shore line: transect 1, 61 meters; transect 2, 35 meters; transect 3, 56 meters; transect 4, 63 meters; transect 5, 77 meters; transect 6, 91 meters; transect 7, 37 meters; transect 8, 82 meters; transect 9, 94 meters; and transect 10, 96 meters.

TABLE 11-Continued

Species Names	Transects, 2 meters wide and 10 meters apart									
	1	2	3	4	5	6	7	8	9	10
Hydrocotyle bonariensis (Pennywort)	X	X	0	0	X	X	X	0	0	0
Asclepias humistrata (Milkweed)	0	X	0	X	0	0	X	X	0	X
Ipomoea stolonifera (Railroad vine)	X	0	X	X	0	X	X	0	0	0
Iva imbricata (Marsh elder)	X	X	X	0	X	X	0	X	0	0
Chrysopsis sp. (Golden aster)	X	X	X	X	X	X	X	X	X	X
Chrysoma pauciflosculosa (Bush goldenrod)	X	X	X	X	X	X	X	X	X	X

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Comments on transects taken in Fort Pickens State Park

The transects were begun 50 meters west of the fence at the beach, near the park gate. This area contained high stabilized dunes with a good grass cover; however, on the back side there were severe blowouts. Winds blowing from the west appeared to be most influential in moving sand.

One plant of interest that occurred behind the dunes in wet depressions was Lycopodium carolinianum. It is common in damp flatwoods throughout Florida, Georgia, and Alabama, but it was found in this unusual habitat growing vigorously.

Quercus geminata, Ilex vomitoria, and Quercus myrtifolia occurred in the vicinity, but did not fall within the transects. Pinus elliottii, slash pine, was observed in the area in a semi-dwarfed condition. Even though these plants were under abnormal conditions, functional female cones from the last three years were present, and remnants of male cones were observed.

Observations made in Fort Pickens State Park and the surrounding Pensacola Area

1. Observations in Fort Pickens State Park:

   a. There were found along the Gulf shore line considerable dune formations of low active dunes, stabilized dunes (stabilized by Uniola), and tall relic dunes being eroded by wind.

   b. Soil type was the white sand of the St. Lucy series. There was very sparse organic cover, and this occurred only under thick vegetation on the relic dunes.

   c. Ilex vomitoria, Quercus geminata, and Quercus myrtifolia formed dense thickets on the faces and back slopes of the relic dunes.

   d. These thickets were severely wind shaped on the exposed side of the dunes.

   e. During the spring and summer months the prevailing winds were from the south; however, during several months in the fall and winter seasons the wind direction was from the north. This was opposite to the northern "leaning" of the wind-shaped vegetation.

   f. Vegetation on the north side of dunes, the back slope, did not demonstrate the wind-shaped forms.

   g. Many of the relic dunes contained Magnolia grandiflora. There was some reseeding of Magnolia where the vegetation was thick.

h. Fort Pickens State Park was situated on the end of Santa Rosa Island; therefore, it was almost completely surrounded by water. The island averaged about 500 meters in width in the park area.

2. Observations in the Pensacola area:

a. A Pleistocene shore line was present in downtown Pensacola. Its bems ran across Palafox Street at the Y.M.C.A. It was traced for several miles east and west.

b. There were occasional formations of relic Sand-Pine Scrub Communities in the North Hill Section and in the area around the junction of 9th Avenue and Carpenters Creek. There were mature communities of this type in West Pensacola and Warringtan.

c. There were many relic dune areas on the Gulf Beach highway.

d. There was conspicuous vegetational zonation at Gulf Beach.

e. Sand-Pine Scrub Communities were common on the west side, around Valparaiso and Niceville, and on the north side of Choctawhatchee Bay.

f. Sand-Pine Scrub Communities were common from Pensacola to Ft. Walton Beach along Highway 98.

g. Good dune formations, active, stabilized, and relic, occurred in the Destin area.

h. There was conspicuous vegetational zonation along Highway 98 east of Destin.

Summary

This chapter presents the plant community as an organization of plants that can be identified and studied. Discussions present characteristics of the shore line plant community, Oak Hammock Community, Sand-Pine Scrub Community, and the Longleaf-Pine/Turkey-Oak Community.

Techniques that can be employed by biology teachers and their students to study plants and their environmental influences are described. The transect is employed as the sampling method most suitable for this type of study.

Information from nine selected areas is presented that has been compiled by the transect sampling method. This information consists of lists of some common plants found in the selected localities. In addition comments and observations pertinent to each locality are included with each plant list. These nine localities furnish examples of all of the community types discussed in this work.

A map is presented as a means of readily locating the nine selected localities (see Figure 15).

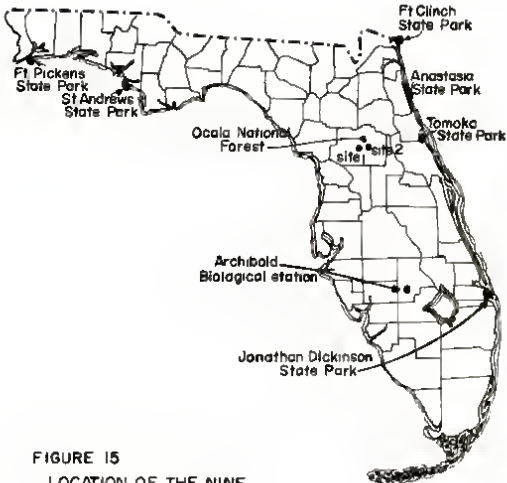

FIGURE 15

LOCATION OF THE NINE DEMONSTRATION AREAS DISCUSSED IN THIS WORK.

CHAPTER IV

PLANT COMMUNITIES USED AS LABORATORIES

Introduction

It is a challenging event to discover a problem. It is a rewarding accomplishment to solve that problem. As pointed out in the beginning of this dissertation, the author believes that most can be gained from the study of plants when they are observed in their natural habitat. Here the plants are subject to an infinite array of environmental influences. Under these conditions the interested student will be able to visualize the problems of plant survival. He can make attempts at answering some of the questions raised by his observations of environmental dynamics.

With the capturing of students' interest as a goal this chapter will be used to present some specific suggestions pointing to important activities occurring within plant communities. A number of observable events that occur in the five general community types included in this study are listed. Additional activities to be included in student investigations are outlined after the discussion of each community.

Facts to be Investigated in All Plant Communities

There are a few things common to all plant communities. The following list includes some of the factors concerning all plant communities that should be investigated. Questions will be raised and some information helpful in finding their answers will be supplied.

1. What are the dominant plants?
2. What are the most common plants other than the dominant ones?
3. What are some of the factors that tend to perpetuate the dominant vegetation?
4. Can some environmental influences upon the plant community be identified? Some of them could be:
   a) Soil types
   b) Drainage
   c) Organic matter in soil
   d) Fire
   e) Storms
   f) Rainfall
   g) Year-round conditions of:
      (1) Soil moisture
      (2) Temperature
      (3) Light intensity, within and without the community
5. What effect does the dominant vegetation have upon its surroundings?
6. Are the dominant plants maintaining their numbers? Evidence of good reproduction rates of the dominant plants is a sign of a stable community.
7. Can a change in the dominant vegetation be detected?
   a) Look for the failure of the dominant plants to reproduce.
   b) Invasion of more prolific plants may crowd out the dominant plants.

The following list contains suggestions and activities that will aid in answering the general questions concerning plant communities.

Some techniques for plant community investigations

1. Make a vegetational analysis of the community. Use the transect technique employed in chapter two.
2. Make observations during several seasons of the year.
3. Establish the soil type. County agents can give assistance here.
4. Check the weather records for the area if they are available.
5. Use topographical maps and aerial photographs in identifying terrain features and community distributions. The U.S.D.A. Soil Conservation District offices usually have a file of local aerial photography.
6. Keep good records of all field observations and collected data. These records should include:
   a) Observations and vegetational analyses from past years.
   b) Exact locations where previous studies were made. These areas should be staked out and reinvestigated over a period of years.
   c) Keep photographic records for quick comparisons to check for seasonal and permanent changes.

Some Observable Factors Found in Plant Communities

A discussion, which uses the locations reported on in chapter three, has been prepared dealing with some of the important factors that can be identified in five types of plant communities. Following the discussion of each community is a list of some suggested activities for field work.

Shore line plant communities

The first communities to be considered are those on or near the shore line. This discussion includes those communities that are most directly influenced by the salt spray and constant winds.

Dune formation.--The mechanics of sand dune formation can be restricted to two aspects, wind-blown sand and obstructions causing the moving sand to pile.

Deposits of sand make up most of the coast line of Florida. There will be a wind blowing in from the sea for many months during the year. This wind force will move the fine grains of sand away from the shore line. As these sand grains are moved they are sorted into varying sizes; the smallest grains are carried the farthest distance.

The smallest sand grains will be those being carried farthest back from the shore where they begin to strike obstructions, primarily vegetation. The species of plants that can survive the continual accumulation of sand around them cause the pile to increase in height and breadth. A single dead shrub will provide enough of an obstruction to begin a small dune formation.

It may be of interest to observe or experiment with artificial dune formation, since the stabilization of sand is of primary importance in the development of Florida beach areas. A straight row of buried shrubbery or piles of sticks and dead plants parallel to the shore line will provide an accumulation of sand in a short time. With the proper design of brush work a pattern of dune formation will begin that will be of great value in controlling the movement of sand. In the Pensacola Beach area there is some use of some fences for this purpose.

The last step in artificial dune stabilization is the planting of the proper species of plants to hold the sand in place. Sea oats and sand grass are the most important native species that can be used for dune stabilization.

Stabilizing effect of vegetation upon sand dunes.

1. One of the more important aspects of the stabilization in sand dunes is the underground structure of the plants involved. Sea oats and other grasses that occur on native and stabilized dunes have an extensive rhizome system. Along with the rhizomes these plants have strong fibrous roots. Upon examination of these underground structures it will be discovered that those dunes that have some stability will have a complex system of rhizomes and roots holding the sand in place.

2. Leaf and stem structures above ground contribute to the stabilization of dunes. If the surface is covered well, there will be little wind action reaching the soil surface. If the surface cover is sparse there will still be a controlling action of the leaves and stems stopping wind-blown sand.

3. Organic matter, contributed by dead plants from previous growing seasons will hold sand in place under understate climatic conditions.

Growth of sea oats on active sand dunes.

1. The most vigorously growing sea oats can be found on dunes that are in the process of changing. That is, sand

ie accumulated around the plants. This makes the dune taller and the plants seem to grow even more rapidly.

2. If dunes are examined that have become stabilized by a covering of vegetation, it will be seen that the vigor of the sea oats has declined.

3. A striking example of the sea oat plant re-establishment in an active sand area was observed in Fort Clinch State Park. On top of the old dunes that have been stable for years (large oaks are growing on them) sea oats are established in the recent blowouts several hundred meters from the shore line (see Figure 6, page 50).

4. It will be of interest to investigate the individual plants of sea oats to discover some of the features that are important to the plant's ability to survive and reproduce under seemingly adverse conditions that prevail in a constantly moving pile of sand.

a) The above-ground parts of the plant consist of a group of leaves coming out of the soil. During the late summer a flower stalk about two meters long will be produced.

b) The underground parts consist of numerous fibrous roots growing out of such rhizomes. The previous years' growths of the plant can be traced by digging out rhizome networks at varying depths within the sand dunes.

c) From discovery of the layers of rhizomes it will be obvious that the plant can survive being covered by heavy layers of sand, by producing rapid rhizome growth which places a new covering of leafy material on the surface of the dune.

d) It will be evident with repeated inspection trips that salt spray does not inhibit growth to any large degree. During many days of the year these plants will be wet with salt spray.

Blowouts of stabilized sand dunes.--Blowouts are the result of wind breaking through the vegetational cover of the dunes and blowing away large amounts of sand. Some blowouts can be observed in Fort Clinch State Park that have started near the shore and have been extended over the years to the rear line of dunes. Tons of sand are blown away, as practically all of the vegetation including large trees is undermined and killed.

What are the causes of these blowouts? These could be caused by almost anything that would cause vegetation on an exposed part of a dune to die. Some of the factors could be campfires, paths where humans decide to approach the beach, heavy wind and salt spray, and extreme temperature variation. It may be that even plant disease or severe attacks by insects, etc., could be the initiation of such changes. There is evidence that paths may be part of the cause of the sand blowout at Fort Clinch. There could be some more direct influences upon the dune such as high tides which may occasionally wash into the fore dune causing a break in vegetational cover.

Constant wind blowing through a cut on a dune line tends to increase the blowout in width, length, and depth. There seems to be little natural control to a blowout until the topography has been leveled and new dunes begin to form. The control of blowouts by man is difficult, but it can be accomplished by creation of new dunes and planting of vegetational cover.

Age of dunes.--With the passage of time a number of factors work toward the establishment of a mature plant community, even on sand dunes. It can be demonstrated in many areas that an oak hammock covers old dune ridges. If during the hundreds of years of shore line development, the sea recedes, some of the severeness of shore environments does not reach those relic dunes left behind.

The development of vegetational cover proceeds toward a more stable type, such as the oak hammock, seen at Fort Clinch, St. Augustine, and Ormond Beach. Under different circumstances these relic dunes could be covered by sand-pine scrub as found at Jonathan Dickinson State Park and along the Northern Gulf Coast from Alligator Harbor past Pensacola Beach.

Some factors favorable to the establishment of these more mature communities are protection from severe wind and salt spray, and more constant source of soil moisture. This last factor is aided by the accumulation of organic soil matter in oak hammocks.

The factors influencing the formation of sand-pine scrub and oak hammock communities will be discussed and enlarged upon in the following statements concerning these community types.

Wind-blown effect.

1. Examination reveals that Ilex vomitoria and species of oak have no bent twigs.

2. The apparent cause of the wind-blown appearance is a matter of killing of the terminal buds. This seems to be the influence for thickening of the vegetation. The buds on the exposed side of the shrub are killed more readily which stimulates more lateral buds to develop. These new buds on exposed sides are killed. The lateral buds that develop on the side of the shrub affording the most protection, produce the most growth. This differential rate of growth will result in plants that have grown more on one side than the other--the wind-blown affect.

3. This influence must be exerted over the shrubs during the short period in spring when the tender buds are susceptible to damage from salt spray carried by winds and desiccation from winds.

4. An added reason for the above statement is that prevailing winter winds may be from the opposite direction. This is true at Pensacola Beach where winds in the spring and summer are from the south; however, during the winter the winds are from the north.

Wind storm damage.--The existence of a number of dead sand pines in St. Andrews State Park stimulated an investigation to discover the cause of the phenomenon. The park superintendent reported that the death was a result of previous storm conditions along the Gulf coast.

Pensacola shore areas were inspected immediately after hurricane Ethel of September, 1960. There was much evidence of wind storm damage. Tender vegetations on the back side of

dunes were killed, especially new buds. Chrysoma pauciflosculosa, bush goldenrod, produces a new growth of stems and buds prior to fall flowering at this time. Plants of this type observed in the beach area were killed back to the old growth. Flowering, thus reproduction, for these plants was prevented for the 1960 season.

A number of large pines were observed near Destin, Florida, on Highway 98 that were severely affected on the Gulf side by wind storm damage. In many instances more than 50 per cent of their leaves had begun to turn brown.

From these two examples it can be seen that the influence of maritime storms can be of considerable importance to shore line vegetation. Killing, dwarfing, shaping, and delay of reproductive cycles are some of the direct effects. In addition, when it is considered that the winds that reached inshore from Pensacola to Panama City during the hurricane Ethel were of less than hurricane intensity. The constant presence of southerly winds must be of considerable influence upon the existing vegetation.

Records at the United States Weather Bureau at Pensacola, Florida, show two days of high winds for the month of September, 1960. Some of the information available shows that on September 7 the highest wind velocity for the month was recorded. This was 37 miles per hour. For the 24 hour

period of September 7, the average wind velocity was 9.3[a] miles per hour. The peak recording occurred during a brief thunder storm. Recordings on September 15 indicate that the greatest wind velocity registered that day, during tropical storm Ethel, was 29 miles per hour. However, the average wind velocity for that 24 hour period was 21.9[a] miles per hour.

One interpretation of these facts could be that the average wind velocity for long periods of time is more influential upon vegetation than brief gusts developed during thunderstorm activity.

Perhaps some of the mechanisms that cause this damage can be discovered. In the shaping of vegetation there was the possibility of the wind bringing salt spray from the Gulf and the desiccation of the tender tissues through evaporation sped up by the same wind. Apparently this sequence could be a major factor in the damage resulting from storms. One must not overlook the possibility of rain washing away salts that may have accumulated upon the vegetation. This fact could be a critical one when observations are made after storms.

Zonation of vegetation.--Along the North Gulf Coast, there are sections of shore line plant communities that exhibit clear vegetational zones. Two localities are of particular value to demonstrate this phenomenon. One location

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[a]These measurements were taken at the Municipal Airport.

is at Destin, along Highway 98, and the other is at Gulf Beach, west of Pensacola.

Zonation is clearest where there are no obstructions to wind blowing in from the sea. The establishment of plants in distinct belts parallel to the shore line appears to be a function of distance from the sea. The first zone consists of typical plants found on active dunes. The next zone, at Destin, consists of low oak shrubs. These shrubs are about one meter tall, formed in a thicket and sheared like a hedge, and extend away from the shore area for at least two hundred meters. At Gulf Beach the second zone consists of plants typical of Sand-Pine Scrubs. The third zone consists of trees in both locations. The trees are predominantly sand pines at Destin, and longleaf pines at Gulf Beach.

Considering that the most severe environmental conditions occur nearest the shore line, it could follow that those plants best fitted for survival would exist nearest to the sea, and conversely, those plants less well fitted would grow further from the sea. As long as there were uniform conditions for extended periods of time, plant distribution would be the result of a combination of two factors. First, plants vary in degrees of hardiness, survival ability, in the shore line community. Second, as the distance from the shore line increases, the severity of environmental forces decreases. Therefore, the best adapted plants for survival in the shore line community will live nearest to the sea. The

less well adapted plants will be established as near as the environmental forces will permit.

Thus, vegetational zonation will occur according to the abilities of plants to survive and the distance of the plants from the shore line.

Light intensity.--Light intensity along the shore lines of Florida is of great importance, but this influence upon vegetation may not be obvious unless one considers that only plants that can tolerate high light intensity will be found on the sparsely covered dune areas. When shrubs and trees become established on some of the older dunes, shade is provided for those plants that require it. Then the new types of plants can be found in these areas. The light is reflected from the white sands, especially those found along the northwestern coast of Florida.

Temperature.--Bodies of water influence the land masses near them by causing the temperature to be more stable over the seasons. However, in parts of the dunes shielded from the breezes coming from the water, summer temperatures may reach past 100° F. This is especially true of the sparsely covered dunes and the swales between the dunes.

Soil moisture.--Contrary to what it may seem the first few inches of soil of the dune sand is usually dry except immediately following rains. This is a result of the absence of organic matter. Some swale formations contain water for part or all of the year. Even under these conditions the dunes are made up of dry soil on the surface. Soil

beginning about six inches deep and below is usually damp. The rhizomes of the dominant dune grasses develop in this moist soil.

Activities for additional investigations in shore line plant communities.

1. Compare the light intensity at the beach with that found in locations more heavily populated with plants.

2. Place some brush in a row on the beach parallel to the prevailing winds and observe the results for the next few weeks.

3. Dig into the sand dunes and measure the soil moisture content at different levels below the surface.

4. Investigate the dune grass rhizome development in newly formed sand dunes. Look for old rhizome networks at lower levels that may have been formed while the dunes were smaller.

5. Study the survival qualities of the dune grasses that allow them to live in moving sand.

6. Leave stakes in front of, on top of, and at the rear of an active dune. Observe the changes that will occur in the size and position of the dune in the following months.

7. Inspect shore vegetation for the accumulation of salt spray at various distances from the surf.

8. Compare the shape and general growth characteristics of a single species of shrub found on the front of dunes with those found on the back side of dunes.

9. Record the direction of the prevailing winds during several periods throughout the year.

10. Watch for new growth to occur on shrubs and trees, especially during the spring. Inspect new growth carefully for evidence of damage. Try to establish the cause of any observed damage. In time passes obscure the effect of new growth damage on the entire plant.

11. Inspect for dead trees and shrubs that may have been the result of wind storm damage.

12. Determine the chief means of plant reproduction in different vegetational zones. Does reproduction occur by rhizomes, seed, or other means?

Oak Hammock Communities

The following remarks are made with particular reference to hammocks that are found in connection with or near shore lines. Usually these hammocks will lie upon relic dunes. Many of the important factors discussed will be observed within the hammock. The thick vegetation creates protective surroundings much as the walls and roof of a house create a more favorable environment for humans.

Soil organic content.--It can be observed that the soil of oak hammocks is covered with a thick mat of leaves and other decaying debris. Upon examination of the soil at depths of 10 to 20 centimeters, one usually finds white sand, identical to that making up the active sand dunes. It would seem that the presence of this organic matter is one of the

important factors in the establishment of the hammocks. At least this material has the effect of making the soil more sponge-like in soaking up and holding water. Many of the plants covering the ground in this community would not survive if the top few centimeters of the soil would dry out as much as do the dune sands.

Which came first, organic matter or the hammock? Probably the organic matter accumulated from vegetation in some of the earlier communities and a few of the more hardy oaks became established. Little by little the hammock grew into being, organic matter accumulating from vegetation, which in turn produced a more luxuriant growth.

Temperature.--The temperature within an oak hammock where high dunes block wind circulation will reach between 90° F. and 100° F. For a few months in the summer temperature could be similar to that found in more tropical regions.

It can be stated that for most of the year, because of the thick vegetation making up the hammock, temperature changes are more gradual than those of most other plant communities. Air circulation is slowed by this condition.

Humidity.--Interior conditions of the hammock are influenced by the high humidity usually present. Some factors that contribute to this humidity are the moisture held by the soil, the thick vegetational cover, and the quantities of water transpired by the vegetation.

Light.--Most of the light reaching the ground within a hammock has been filtered by the vegetational cover provided by the trees and shrubs. Only occasionally will there be much direct sunlight. This occurs in open areas, and the ground cover here is different from that found under the tree-shrub cover. Most vegetation ground covering within the hammock is shade tolerant, and may never occur in any other situation unless shade is provided. Plants that can grow in sunny as well as shady habitats will demonstrate a difference in form or proportion, when found within the hammock. The influence of light intensity upon the growth of certain plants can easily be observed by comparing a single species growing in sunny and shady locations. Some plants that may be used in this comparison are yaupon, magnolia, redbay, and beautyberry. Several herbaceous plants may be recognized as being present in the hammock as well as on dunes.

High humidity, warm temperature, and low light intensity combine to produce a habitat well suited for a number of plants. Epiphytes will grow well in the trees where they must depend upon frequent rain and high humidity to maintain their moisture supply. The most common epiphyte found in northern Florida is Resurrection fern. One of the small native orchids is occasionally found as far north as Alabama and Georgia. Orchids, ferns, and air plants are increasingly more common in hammocks further south.

One of the groups of plants most important to the manditioning of the soil organic matter is the fungus plants. These plants are not mentioned in the population descriptions of plant communities in this study. They exist as microscopic threads and are rarely seen except when a reproductive structure, such as a toadstool, is produced. The environment within a hammock is ideal for the growth of fungus plants.

Layers of storage formations.--Because of the differences in temperature, light, and moisture at different levels in the oak hammock there are three layers of vegetation. The top layer or canopy consists of the tops of the dominant trees, oaks, magnolias, and bays. These trees receive direct sunlight yet their roots are in a relatively cool and moist position.

Small trees and shrubs make up the second layer. All of these plants must be shade tolerant or they will not survive.

Herbaceous plants, ground cover, and small shrubs make up the lowest layer of vegetation. Under conditions of low light intensity and highest humidity, these plants often produce a very thick mat of vegetation. However, in many instances the combination of the two upper layers of vegetation reduces light intensity to such a level that the ground cover cannot survive. Only leaves and other organic debris will be found in these situations.

Reproduction and competition for survival.--Moisture,

temperature, and soil cover in hammocks are ideal for seed germination. One should expect to find large numbers of seedlings of existing plant types. Competition for survival is intense. Only a very few of these plants will reach maturity. Some factors important to the survival of seedlings are rate of growth, shade tolerance, individual vigor. A group of seeds from a single plant will produce seedlings with variation in growth characteristics. A few seedlings will be much more vigorous than the others. These will excel in growth and leaf area development. This means that they will begin to shade out the other seedlings in their generation, if they are growing close together. The vigorous ones may be able to outgrow other species in their vicinity. Not only does the seedling have to compete with its own generation, but it must compete with adult plants for light, moisture, and minerals. Chance plays a part in survival of seedlings when they develop in positions more favorable to growth. One instance occurs when seeds fall in or on the border of an opening in the hammock. Here light is plentiful and competition from mature plants is much less.

In general for a seedling to produce a mature plant within a hammock it must be shade tolerant in its juvenile growth period. Any plant of a species not shade tolerant will die if its seeds do not fall in an open space. A healthy plant community will have the capacity to maintain itself. Sometimes this is most apparent when the death of a

large trees has allowed more light at the ground level. Reproduction of kind should be looked for by the student.

Invasion of hammocks by sand.--The seaward boundaries of hammocks in Fort Clinch State Park in particular hammocks on the East Coast of Florida in general are subject to a continual encroachment of sand. It is interesting to observe that a number of the trees and shrubs can exist for a few years as their trunks are covered and pushed by the sand. The vital factor involved here is time. Can the hammock vegetation re-establish as the new sand pushing in or is the movement too rapid? Most of the movement of sand in the Fort Clinch area is too rapid under the present set of circumstances for the hammock vegetation being covered to survive.

Some factors that would be of value to plants in this situation are the ability to develop adventitious roots as the sand covered their lower parts, rapid growth, and prolific rates of reproduction. Few of the dominant hammock plants possess these qualities. As a result of this deficiency the sand invasion continues until some physical factor such as distance from the shore or a protective barrier develops nearer the shore line limits the sand movement.

Activities for additional investigations in Oak Hammock Communities.

1. Inspect plants of the same species growing within and outside the oak community. Do the differences in light intensity cause variation in leaf and stem development?

2. What is the protective value for plants growing within the hammock? Compare cold damage to plants inside and outside.

3. Is there a distinction between shade-tolerant plants and those plants that cannot survive in direct sunlight?

4. Search the soil cover debris for decay organisms such as various fungi and slime molds.

5. Are there many seedlings in the hammock? Compare numbers with size.

6. What young plants are found in openings? Are the plants of the same species as those within?

7. Place stakes at the bottom of invading sand dunes. What is the rate of movement?

8. Establish which type of vegetation is growing on the new sand, hammock plants or dune plants.

Sand-Pine Scrub Communities

In reference to the description of the Sand-Pine Scrub in chapter three and the discussion in chapter two of the origin of Florida sands, it should be kept in mind that the origin of the soils of the scrub community is probably from shore line deposits. This plant community could be compared to one found on stabilized dunes, at least with reference to soils, and its similarity in that some plants occur in both places.

Soil type and soil cover.--Only in the thickest Sand-Pine Scrubs is a soil cover present. Even here there are occasional open spots. The soil almost always consists of white sand with hardly any organic content. Apparently what little soil cover is present as the surface oxidizes completely before it can be incorporated as organic matter within the soil. From this aspect then, the soil of Sand-Pine Scrub whether it is inland or coastal is similar to the soil of active and stabilized shore line dunes.

Ground cover in open areas.--As in other plant communities in the sandy area of Florida the Sand-Pine Scrub Community contains several species of lichens. The most conspicuous ones are those that are often called deer moss. These species grow in the open spots through the Sand-Pine Scrub. Lichens have no roots; therefore, these plants depend upon rain for their moisture requirement. During the rainy seasons these lichens carry on normal growth processes. In periods of dryness these plants go into a state of dormancy, since the moisture present in the soil surface layer is not adequate to support growth.

Relic dunes.--Throughout the state Sand-Pine Scrubs can be found upon relic dunes. This can be seen along the Florida East Coast in clear instances from north of St. Augustine along U. S. Highway #1 to the Fort Lauderdale area. This community type also occurs in many places on the north Gulf coast of Florida from Alligator Harbor to Mobile,

Alabama. Sand-Pine Scrubs occur on the dune-like deposits of white sand inland. Some correlation of Sand-Pine Scrub occurrence can be found with the positions of old Pleistocene shore lines that can be selected from topographic maps. Excellent correlation is found with shore line deposits in Highland and Levy Counties. The photographs used to make up the topographic maps are available and one of these series is used by A. L. Lacsale to predict occurrence of dunes in the Ocala Scrub.[1]

The leaning of sand pines.--One characteristic of sand pines in many of the areas where they grow is their leaning or slanting all in one direction. This feature is particularly noticeable in Jonathan Dickinson State Park (see Figure 13, page 73). Two explanations have been given for this occurrence. One is that the influence of the prevailing winds causes the tree to lean with the winds. This explanation appears to be a logical one for the trees at Jonathan Dickinson since most of the trees lean westward, with the prevailing wind coming from the Atlantic Ocean.

The other explanation is that extreme winds cause the leaning. In Florida this could be caused by winds of or near hurricane force.

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[1] A. M. Lacsale, "The Origin and Successional Relationship of Sandhill Vegetation and Sand-Pine Scrub," Ecological Monographs, Vol. XXVIII, n. 4, (October 1958), pp. 307.

Size of sand pines.--Sand pines develop into tall, well developed trees in stands occurring in interior localities. Sand pines that occur in coastal areas are smaller and often exhibit characteristics produced by severe environmental conditions. The best example of this is a comparison of trees found in the Ocala Scrub with those found in coastal dune areas.

Storm damage in sand pines.--The sand pines seem to be more susceptible to wind and salt spray damage than some of the oaks, saupon, and other woody plants. The former occurrence of sand pines along some coastal areas may be evident by their dead trunks.

Fire and reproduction of sand pines.--Sand pines in peninsula Florida produce cones that may never open for the dispersal of seed. These cones remain closed and attached to the trees, in some cases until the cone becomes buried in the wood making up a limb. The time required for a pine cone to develop mature seed is between one and two years. The beginning female cones can be observed in late winter or early spring on the tips of the branches on new growth. Pollination takes place at this time. After a year or more the mature cone will be found on the branch well back from the tip, on the previous year's growth (see Figure 14, page 91). The age of a pine cone can be estimated by counting how many cones are between it and the end of the stem.

These cones can be called persistent cones. There is one thing that will cause them to open and discharge their seed, heat. When a fire burns through a sand pine forest, many of these persistent cones open and millions of seed are released and carried with the updraught from the fire. This can carry the seed hundreds of feet up in the air from where they will continue to be influenced by air currents until they settle back to the earth, dispersed over a wide area. Many will fall in areas just burned out by the same fire that opened their cones. Burned areas can be reseeded from plants destroyed in the fire. Such an area can be observed in the Ocala National Forest, as mentioned in the description of that area.

More often than not, the cones on the sand pines in western Florida will open at maturity and the seeds will be dispersed, producing a continuous source of seed for reproduction. It may be of interest to establish the line where cones produced by these trees are dominantly closed or open at maturity. Fire as an aid to seed dispersal seems to be of greatest value to the sand pines in peninsula Florida. Whether the cones open or not they are persistent on all of the sand pines, regardless of where the trees are found.

Boundaries of Sand-Pine Scrub Communities.--As previously discussed, Sand-Pine Scrub Communities occur primarily on the white sands of St. Lucy type soils. This is a distinctive community characteristic. A spectacular illustration of the sand pine-white sand relationship can be found

on the boundaries of Sand-Pine Scrub Communities. Here the sand pines occur up to the edge of the white soil. Three other types of plant communities continue and are well defined. This exact boundary is not always present. At Archbold Biological Station there is a narrow transition zone between the Sand-Pine Scrub Community and its adjacent communities. Within the transition zone can be found a few plants characteristic of both communities. However, the usual occurrence is for the Sand-Pine Scrub Communities to be well defined and restricted to white sand areas. This is especially true in southern Polk and Highland Counties at the end of the "ridge."

Comparison of species of plants found in coastal areas with those found in inland Sand-Pine Communities.--There are a few indicator plants found in Sand-Pine Scrub Communities. These may occur from one end of the state to the other. Sand pine, rosemary, saw palmetto, and scrub oaks make up the most prominent of these species. Whatever the peculiar growth requirements that each of these plants may have, they are satisfied in all of the white sand areas. It may be considered that, with the exception of high winds and salt spray, the general environmental conditions of the Sand-Pine Scrub Communities are similar inland and along the coast. The conditions are severe with respect to moisture retention by the soil. High and low temperatures are experienced within the seasons of a year. These factors required for

plant survival in coastal areas are also required for survival in inland populations. Apparently the indicator plants possess these survival characteristics.

Isolated stands and local species.--If one would map the Sand-Pine Scrub Communities, it could be observed that a characteristic pattern of their distribution is their "isolation into islands." On some of the "islands" in peninsula Florida certain species occur that are found in no other areas. It may be of interest to correlate the occurrence of some of these species with the relative time of the shore line formation. For instance, those species restricted to central Florida, Sabal setonia, Carya floridana, and Garberia fruticosa could have populated that area during the early Pleistocene period. One herbaceous plant, Amoryprum ohlingeri, occurs only in the scrubs of the southern ridge area, the last in the island chain in the Pleistocene period.

An explanation for the plant distribution pattern could be as follows:

With the passage of time along with the fluctuation of sea level, these plants would have been isolated from near relatives. This isolation would allow genetic differences to arise in separate groups of plants of the same species.

Different species of plants can be found filling identical ecological niches in widely separated scrub communities. Glinopodium ashei, a shrubby mint, occurs in the south lake region in peninsula Florida. A species that has the same appearance growing in the scrubs of Northwest

Florida is Conradina canescens. Another example is the occurrence of Carya floridana, restricted to peninsula Florida, while in Northwest Florida the same ecological niche is filled by a similar species, Carya pallida. Species may be restricted to small areas, but their ecological niche is often filled by similar species in distant communities.

Activities for additional investigations in Sand-Pine Scrub Communities.

1. Locate Sand-Pine Scrub Communities on aerial photographs, or Geological Survey Maps and inspect the terrain for relic dune formation.

2. Examine the roots of some of the small herbaceous plants. Does the length of roots differ markedly between short seasonal plants and those that are perennial?

3. Examine the structure of a sand pine seed. Why will air currents carry a seed of this type for long distances?

4. Gently heat some young mature sand pine cones in a hot air oven. Note the temperature when the cones open. Remove the seeds and test them for germination potential.

5. Identify as many types of survival mechanisms as possible among the different plants. As examples, the lichens go into dormancy during dry periods, and sand pines rely upon air currents for seed dispersal.

6. Determine the direction of the prevailing winds in the community. Is the direction different during the growth season of the dominant vegetation?

7. In coastal localities, establish which plants exhibit the most damage due to wind after storms. Be careful to note the condition of the buds so that it can be established whether or not new growth was in progress when the damage occurred.

8. In peninsula Florida, inspect recently burned sand pine areas for evidence of reseeding.

9. Along the north Gulf Coast, stake out a few areas and count the number of trees with open cones and closed cones. Compare the percentages with those found in each plot.

The following activities may require the investigators to travel widely separated locations to gather information. It may be worthwhile to establish working agreements between biology classes in separate schools so that information could be shared concerning similar communities in different parts of the state.

10. Compare the species of plants found in coastal Sand-Pine Communities with those found in the inland Sand-Pine Communities.

11. Plot on maps the areas in the state where species are isolated.

12. Indicate on maps where sand pines occur with different cone characteristics.

13. Compare maximum sizes of sand pine in coastal areas with those found inland.

14. Compare thickness of the growth rings of sand pines in coastal communities with those in inland communities.

Longleaf-Pine/Turkey-Oak Communities

The Longleaf-Pine/Turkey-Oak Community appears to be quite different from the Sand-Pine Scrub Community, but the two have many similar soil characteristics as shown by Miller.[2] In effect both are practically dry during much of the year. The Longleaf-Pine/Turkey-Oak Community has two short periods when a number of herbaceous plants grow and flower. These periods are in the spring and fall. Other than the short periods of time when the herbaceous plants are present, the community is identified by its two dominant trees, longleaf pine and turkey oak, and wiregrass.

Grass stage of Longleaf Pine.--One of the interesting facts about the longleaf pine is that it remains in a short slump, similar to a tuft of grass, for several years. While pine seedlings of other species continue steady growth after seed germination, the longleaf seedling grows so slowly for its first few years that most plants nearby will have opportunity to overshadow the pine. There may be advantages to

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[2] R. B. Miller, "Ecological Comparisons of Plant Communities of the Xeric, Pine Type on Sand Ridges in Central Florida" (unpublished Master's thesis, University of Florida, 1950), pp. 21, 22.

this slow start, but the fact remains that quick growing plants will have the best chance of survival over the longleaf pine.

Wiregrass competition.--In most Longleaf-Pine/Turkey-Oak Communities the principal ground cover is wiregrass, Aristida stricta. This grass may be sparsely scattered or it may constitute a dense stand. When wiregrass occurs in dense stands it is one of the best competitors for survival in a plant community.

In reforestation programs in northwest Florida, this grass is plowed under in order to insure good survival rates for the newly planted pine seedlings. Under natural conditions the presence of this grass may control the reseeding of many community members.

Shading-out of longleaf pine seedlings by hardwoods. Typical hammock plants have shade-tolerant characteristics. The reverse is true of longleaf pine. This plant must have direct sunlight to grow. This fact coupled with the statement above about its slow growth habit in the seedling state, points up a weakness of the longleaf pine to being choked out of its own community by shade-tolerant trees. These shade-tolerant trees are the oak, hickory, and black gum. These trees are known as hardwoods. When the soil organic matter accumulates in a Longleaf-Pine/Turkey-Oak Community the seeds of hardwoods have a good chance to germinate. If moisture conditions are favorable these hardwood seedlings will mature

and provide much more shade and organic matter than was present in the Longleaf-Pine/Turkey-Oak Community. Longleaf pine seedlings located in the shade will not survive. As the years pass fewer pine seedlings will succeed in the community, and more hardwoods will reach maturity. This procedure will theoretically continue until only the hardwoods are present. Thus a new community will have replaced the Longleaf-Pine/Turkey-Oak Community.

The effects of fire on the Longleaf-Pine/Turkey-Oak Community.--The following discussion will be divided into several parts since there are different effects of fire on the various plants important to the community.

1. Effects of fire on longleaf pine.--A severe fire will kill longleaf pine just as it will other plants. However, the seedlings of this pine will survive a grass fire better than other plants in the community. The particular part of the pine seedling that is resistant to heat is the bud. It can be observed in a burned area that the longleaf pine seedlings have survived, even though their leaves may have been consumed, and their growth slowed.

2. Effects of fire on turkey oak and other hardwoods. Hardwoods are usually more quickly killed by fire than are pines. When a community of this type burns, most of the hardwoods will be eliminated. On the other hand the turkey oak remains as a co-dominant plant due to this ability to produce new growth from its extensive root systems. Not only

is this root system protective for the turkey oak in times of fire, but it is also a major means of reproduction and spreading of the species within the community.

3. Effects of fire on the growth of herbaceous plants. Since wiregrass is the dominant ground cover in most communities, its presence hampers the growth of the seasonal herbaceous plants. If a fire burns the wiregrass at the appropriate time, an abnormally abundant growth of herbaceous plants will be observed. This minor change in the plant population may be accounted for by at least two methods. First the burning of the wiregrass reduces the competition for light and water. Seedlings have a better chance to survive. Secondly the fire could conceivably damage the seed coats of many seeds just enough to cause a higher percentage of germination. Whatever the cause of this increase in herbaceous plant population, the increase is short-lived. Fire may burn wiregrass to the ground, but the plant's tough root system is not harmed and the plant will grow back to its normal state in a few weeks.

4. Fire and the existence of the community.--In light of the various effects of fire on plants in the Longleaf-Pine/Turkey-Oak Community, there are some important conclusions to be drawn. First, the abundance of plant species will change with the occurrence of fire. Hardwoods will be killed and the seasonal herbaceous plants will be temporarily present in greater numbers. Second, the longleaf pines and turkey oaks possess better survival characteristics than do

other community members, therefore, they are more likely to remain after a fire. It may well be that present Longleaf-Pine/Turkey-Oak Communities have been maintained for hundreds of years by accidental burning. Otherwise as organic matter accumulates hardwoods may invade and become the dominant trees in a community.

Activities for additional investigations in Longleaf-Pine/Turkey-Oak Communities.

1. Observe the differences between longleaf pine seedlings growing in the shade and those growing in direct sunlight.

2. Make vegetational analyses to determine whether the hardwoods are invading the community.

3. Inspect the bark of trees for fire damage. A recent fire will leave the bark charred on the tree trunks. Old fire damage is indicated by the occurrence of new bark in the cracks on tree trunks.

4. Record the species of plants that have survived in a community that has been burned recently. Establish the size of the smallest surviving pines.

5. Look for the reproduction of the two dominant plant species. What are the most common methods of reproduction for turkey oak and longleaf pine?

6. Compare the occurrence of herbaceous plants in the community during the different seasons of the year.

7. Observe how these herbaceous plants maintain their seasonal growth habits. Do they reproduce by seed, or do

they survive primarily by means of underground roots or tubers? Note if some of these plants are present most of the year in an inconspicuous low-growing form.

8. Compare the occurrence of plant seedlings with the thickness of wiregrass cover.

Grass-flat, Mangrove, and Marshgrass Communities

This last section of observable events in plant communities pertains to the area included in the transects taken in the Anastasia State Park. There are similar areas along the coast line of Florida that may be used for study, but these were not included by the author.

Invading sand.--At this locality the dune ridge is low and discontinuous. During high winds and stormy conditions sea water breaks over the dune line and drains over the grass-flat into the lagoon. This, plus steady wind from the sea, causes sand to move over the grass.

Vegetational zonation.--Upon close examination of the vegetation zones it will be discovered that those lower than the grass-flat will be underwater during part of the day. With more careful investigation it can be seen that each zone has a slightly different water depth at high tide. In order of occurrence from the dune line toward the lagoon are: the grass-flat, normally above the high tide level; the Mangrove Community, in shallow water during high tide; and the marsh-grass covered by 20 or more centimeters of water at high

tide. Vegetational zonation is apparently influenced by ground elevation and thus by tides.

Activities for additional investigations in Grass-flat, Mangrove, and Marsh-grass Communities.

1. Mark the boundary of invading sand. Keep a record of the rate of movement.

2. Look for objects in the grass-flat that may have been moved by water.

3. Establish the high tide mark in the flat. What is the maximum depth of water at high tide for each of the communities?

4. Determine whether it is the depth of water or the length of time covered by water that is important in the formation of zones.

Equipment to be Included in Preparations for Activities

A list of equipment to be used on a field trip should be made well in advance of the event. This will give the students sufficient time to procure the proper materials necessary for a thorough investigation. The following items have been included because of their inexpensiveness and simplicity. It is unnecessary to purchase complex equipment for the type of studies suggested by the author. Some of the most fundamental aspects of plant communities can be discovered through observations and the use of a few simple measurements. This list is complete enough to accomplish most of the work in the suggested activities.

1. Small diameter ropes marked in meters, or a steel tape marked in meters.

2. A piece of lattice one meter long painted black on one side and white on the other or marked off in decimeters--to show relative size in photographs.

3. Stakes--wood temporary and metal permanent.

4. Plant presses.

5. Field guides, plants.

6. Clip boards with paper and pencils.

7. Compass--keeping transects straight through dense growth.

8. Photographic equipment--(A light meter is highly desirable because of the intense light in white sand areas).

9. Containers if soil samples are needed.

10. A snake-bite kit.

11. Shovels.

Planning a Field Trip

For the most effective use of time and energy, a field trip should be carefully planned. After an area for study has been selected, decide upon what information is required, and organize the plans in such a manner as to obtain this information most efficiently. Next, select the equipment necessary for the operation. A list of suggestions that will be of value in preparing for field work is included here.

1. Select an area for study and secure permission of the park superintendent or owner to visit the area.

2. Make a list of the things to be investigated. Don't include too much. Field work is tiring.

3. Divide the class into teams of two or three students each to insure experience for all and a complete collection of data for the class.

4. Complete all notes and data collection on the spot.

5. Make sure of reliable transportation. Be prepared to pull automobiles out of deep sand. With careful driving bogging down can usually be avoided.

6. Set up dates on a calendar for visits to the same area during different seasons.

7. Complete all data and reports and discuss the findings in class as soon after the field trip as is practical.

8. Make plans to make additional trips if more observations are required.

9. Keep permanent records of all studies. They will be of value for long range studies.

Summary

This chapter provides a guide for the investigation of plant communities. This guide is based upon some common biological and environmental events that occur or are present in most communities. Salient features of each of the community types are presented in detailed discussions. These features are those that can be employed by the teacher to begin investigations of plant communities. A list of equipment to be utilized in field work is included. The equipment required for this work is inexpensive and most of the articles can be found either at school or provided by students. Suggestions for the planning of field investigations are made for the teacher. Individual and class investigations will be most valuable to the learners if each trip is carefully planned and executed.

CHAPTER V

SUMMARY

Statement of the Problem

This work is designed to provide teachers with material for the study of plant life and its interaction with environmental factors. The plant community is used as the basic vegetational unit. Clarity of community types and accessibility of the communities to biology classes are criteria used in their selection.

The approach is based primarily upon field observations. With careful planning the dynamics of environmental events can be investigated as they occur. Shore line areas are especially useful for these investigations. Therefore, students will be most impressed by the discovery of biological relationships by plant study in situ.

Geological Background

A discussion of Pleistocene geological history is presented to show the origin of the present Florida sands. Emphasis is placed upon the formation of shore lines during the interglacial periods. The selected plant communities

occur on present and relic shore line areas throughout the state. The geologic origin of the soils of the included communities is directly related to the occurrence of the old shores. The soils discussed are similar to the soils found on the present beaches.

Findings

Four general types of plant communities, which exist on sandy soils, Shore line, Oak Hammock, Sand-Pine Scrub, and Longleaf-Pine/Turkey-Oak, were discussed and identifying characteristics of each have been included. These communities were investigated by vegetational analyses. The technique used was that of taking transects in type communities. The information gained is prepared in tabular form to provide plant lists as well as to give evidence of relative abundance of the conspicuous species. Comments are presented to add pertinent information to each analysis, and observations of environmental factors are made in the vicinity of the demonstration areas.

The localities selected for analysis occur in nine parks and protected areas where it is unlikely that the influence of man will disrupt the conditions described.

Application of Findings

In the application chapter several aspects of each community are discussed. It is pointed out that there are

many facts that have not been brought forward in this work to be explored by students. Also suggestions for further investigations are made in conjunction with the examination of environmental factors within these communities. These ten, are only the beginnings of field work. Students can extend their explorations into plant communities indefinitely. An equipment list is included to aid in the preparation of field trips. An additional advantage of this study material is that almost all required equipment will be in the possession of class members, or will be of small expense in any case. An aid to planning field trips is provided for the teachers' use. From material presented in chapter four, teachers and students are provided with a starting point for field investigations designed for the high school level.

Proposals for Future Studies

Further investigations such as those which follow would aid Florida teachers in using the living things in their environment in the teaching of biology.

1. Develop similar materials for other plant communities, for example those found in aquatic and semitropical habitats.

2. Correlate the animal communities with plant communities. Animals are usually associated with specific plant communities.

3. Make plant and animal lists for local areas along with study materials needed by the elementary and junior high school teachers.

4. Study the feasibility of in-service training courses dealing with local plants and animals.

5. Investigate the microflora and microfauna of selected plant communities.

Conclusions

This work was designed to provide live teaching materials for high school biology teachers. The following conclusions were made after the preparation of these materials.

1. Practical aid is given to teachers in gaining more botanical information in their localities.

2. This work demonstrates that plant communities are readily usable as laboratories.

3. The sources of material are available in a large portion of the state.

4. Valuable field work is provided for high school biology classes at minimum expense and equipment requirements.

GLOSSARY

ADVENTITIOUS ROOTS: roots that arise from tissue not normally producing roots.

BLOWOUT: an interruption in a sand dune caused by wind blowing the sand away.

CANOPY: a vegetational covering, such as the tops of tall trees in a hammock, under which other plants grow.

CO-DOMINANT PLANT: a plant of equal importance in a community of two conspicuous, dominant plants, i.e., Longleaf-Pine/Turkey-Oak Community.

DOMINANT PLANT: the most conspicuous tree or large plant in a community. The community name is derived from this plant, i.e., Sand-Pine Scrub.

EPIPHYTE: a plant growing on or attached to another living or dead plant, but not parasitic upon it.

EVERGREEN: a plant that never sheds all of its leaves at one time.

GRASS-FLAT: a level area covered by grass.

GROUND COVER: low-growing plants such as grasses or lichens.

GROWTH RING: a conspicuous ring formation seen in a transverse cut of a woody stem. It is caused by seasonal growth.

HABITAT: the location and, by implication, environmental conditions where organisms normally live.

HARD SEED COAT: the covering of a seed that will not permit the uptake of water. The seed will not germinate until the coat is scratched or penetrated by some mechanical or chemical means.

HARDWOODS: trees that are noted for their hard wood and usually shed all of their leaves during the fall, i.e., oaks.

HERBACEOUS: tender plants that have a succulent stem growth. These plants are usually killed by frost.

INDICATOR PLANTS: any of the conspicuous plants normally associated with a particular kind of plant community.

PERENNIAL: a woody or herbaceous plant living for several years.

PIONEER PLANTS: plants that are the first ones to become established in a bare area.

PLANT COMMUNITY: a group of plants living together in a characteristic habitat.

RELIC DUNE: a dune that has been stabilized and left by the recession of the sea shore.

RHIZOME: an underground stem.

SHADE TOLERANCE: the ability of plants to grow under shady conditions.

SOIL COVER: debris from decaying vegetation covering the soil.

SP.: an abbreviation of the word species. This is often used in the scientific name of an organism when the exact species is uncertain.

SPP.: an abbreviation of the plural of species. This is used when two or more species of the same organism are indicated.

SWALE: the low ground between sand dunes.

TRANSECT: a belt type measuring technique used in vegetational analysis, usually a narrow strip about two meters wide by several hundred meters long.

TUBER: an enlarged root that functions as a food storage organ.

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BIOGRAPHICAL SKETCH

William Yancey Bennett was born April 8, 1929 in Avon Park, Florida. He attended Avon Park public schools and was graduated from high school in 1947. Undergraduate studies were begun at the University of Florida, where the degree Bachelor of Science in Education was awarded in 1951. Studies were begun in the Graduate School of the University of Florida in 1954 where the degree of Master of Education was awarded in 1955. He enlisted in the United States Army in 1951 and served in the United States and Korea for about two years. He was separated from the United States Army Signal Corps with the rank of 2nd Lieutenant. For the past four years he has been instructor of biology at Pensacola Junior College, Pensacola, Florida.

This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Education and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Education.

June 5, 1961

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